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The Committee on Climate Change: A policy analysis

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The Committee on Climate Change: A policy analysis*

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Discussion Paper

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Abstract

Domestic action on climate change is increasingly important in the light of the difficulties with international agreements and requires a combination of solutions, in terms of institutions and policy instruments. One way of achieving government carbon policy goals may be the creation of an independent body to advise, set or monitor policy.

This paper critically assesses the Committee on Climate Change (CCC), which was created in 2008 as an independent body to help move the UK towards a low carbon economy. We look at the motivation for its creation in terms of: information provision, advice, monitoring, or policy delegation. In particular we consider its ability to overcome a time inconsistency problem by comparing and contrasting it with another independent body, the Monetary Policy Committee of the Bank of England.

In practice the Committee on Climate Change appears to be the 'inverse' of the Monetary Policy Committee, in that it advises on what the policy goal should be rather than being responsible for achieving it. The CCC incorporates both advisory and monitoring functions to inform government and achieve a credible carbon policy over a long time frame. This is a similar framework to that adopted by Stern (2006), but the CCC operates on a continuing basis. We therefore believe the CCC is best viewed as a "Rolling Stern *plus*" body. There are also concerns as to how binding the budgets actually are and how the budgets interact with other energy policy goals and instruments, such as Renewable Obligation Contracts and the EU Emissions Trading Scheme. The CCC could potentially be reformed to include: an explicit information provision role; consumption-based accounting of emissions and control of a policy instrument such as a balanced-budget carbon tax.

Keywords: Climate change, Carbon policy, Independent body, Time Inconsistency

JEL codes: Q48, Q54, Q58

1. INTRODUCTION AND BACKGROUND

Increasing levels of anthropogenic greenhouse gas (GHG) emissions are rapidly warming the climate and raising global and regional temperatures. The potential impacts involved in climate change are on an unprecedented scale and have irreversible consequences for the entire planet. According to the scientific consensus this warming will permanently alter ecological conditions and typically adversely affect the human environment, resulting in droughts, rising sea levels and species extinction accompanied by all the human repercussions that these changes entail. This will occur unless there are vigorous policy responses for mitigation and adaptation. Unfortunately these responses and solutions are not simple because there are certain characteristics of climate change that render it a unique problem.

Although knowledge and understanding have evolved dramatically over the last decades, there is still a large degree of uncertainty associated with many aspects of the science and economics of climate change. The complex and intricate nature of the underlying mechanisms means that little regarding these predicted changes can be said with precision, especially given the long time frame involved. This uncertainty underpins many of the difficulties faced by climate change policy, and makes finding an agreed solution extremely difficult. [1] One major scientific problem has been in understanding how GHG concentrations directly affect the temperature because the climate system is inherently complex and unpredictable in nature. Only recently has it proved possible to attach probabilities to temperature rises associated with different GHG concentrations (Stern, 2009). This has allowed some quantification of risks but the science is still far from definite and precise results are heavily dependent upon model specification.

GHG emissions are a worldwide negative externality, of a scale that is unprecedented. It is particularly difficult to deal with a public bad produced by all nations (with some nations producing at lot more than others[2]) because no worldwide authority exists with the power to regulate emissions. The uncertainty involved also means we cannot

[1] See McKibbin and Wilcoxen (2002) and Ingham and Ulph (2005) on uncertainty in climate change
[2] See MacKay (2009) for a detailed breakdown

realistically agree on how to undertake a cost-benefit analysis which would receive worldwide consensus on the exact implications of potential temperature rises. Agreeing on how to measure and value the costs and benefits of mitigating climate change is extremely difficult and involves many moral decisions. For instance, discounting plays a major role in any economic analysis of climate change because, with positive time preference, future outcomes should be discounted more heavily than the same outcome today. However, agreeing on an appropriate discount rate has been one of the most contentious aspects of the economic analysis of climate change and the choice of discount rate will seriously affect the outcome of any analysis in terms of the balance of costs and benefits.[3] Discounting is also linked to the intergenerational element of climate change analysis because many of the people living today will not be among those most directly affected; it will be future generations who are impacted most severely if no action is taken. The actions of citizens today will affect the rights, opportunities and freedoms of future generations and so the assumptions made on how we value costs and benefits to future generations within our discount rate will heavily impact upon any analysis as well. However, it is also the case that those future generations will likely be wealthier than the current one and can therefore better afford the costs of mitigation and adaptation. Therefore it is inescapable that ethical and moral discussion must form part of the analysis on discounting and intergenerational aspects.[4]

"In short, uncertainty is the single most important attribute of climate change as a policy problem. From climatology to economics, the uncertainties in climate change are pervasive, large in magnitude and very difficult to resolve."(McKibbin and Wilcoxen, 2002, p115)

In practice, given the worldwide scale of the issue, we must rely on voluntary international agreements to coordinate action to tackle climate change. International agreements, however, are accompanied by a whole host of coordination and

[3] For instance see Stern (2006) for a methodology and responses and criticisms to Stern from Weitzman (2007) and Nordhaus (2007). It is possible that a discount rate could also take a zero value or even be negative.
[4] For a recent discussion of these see Stern (2009) chapter 5. Also see Dietz (2008) for an overview of various other approaches to the economics of climate change.

distributional issues, especially under uncertainty.[5] Getting a coalition of countries to agree on how to allocate emissions reductions among themselves is a near impossible political task. There are large free-rider incentives that exist which limit the amount of action likely to be taken by individual countries.[6] The global bad of climate change requires worldwide emission reductions in order to stabilise temperature, but each country has an incentive to let the others do the work to reduce emissions and free-ride without any effort. Therefore we have something similar to a prisoner's dilemma where no country is willing to make significant reductions given that the others will likely benefit by not reducing their emissions and so we have a Nash equilibrium where no country takes action. However, the problem can be seen as a repeated game where collusion over time is a possible stable solution. Achieving that collusion through an international agreement, given the number of countries involved and their heterogeneity has proved incredibly difficult to achieve in practice. On top of that, each country has different growth rates, physical endowments and historical emissions paths which bring in equity and fairness considerations to negotiations. Reaching an agreement on emission reduction targets is especially difficult given that developing countries are likely to be the first and most adversely affected by climate change yet are the least responsible for the increased emissions levels over the last century[7]. Achieving any political consensus on climate change has therefore proven to be a substantial challenge.

There has been one international agreement that imposes reduction targets on GHG emissions for developed nations, the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). It was agreed upon in 1997, ratified in 2005 and runs from 2008-2012. Although Kyoto has been seen as a necessary initial step, it has achieved only moderate success so far and suffers from a lack of participation and ambition (Barrett and Stavins, 2003). Kyoto allows for the use of flexible market mechanisms in tackling emissions reductions; International Emissions Trading, Joint Implementation and the Clean Development Mechanism.[8] In theory these should allow abatement to take place in the most cost effective manner

[5] There is extensive literature on coordination and distribution with regards to the Kyoto Protocol as well as other IEAs. Among other see Bohringer, (2003) and Barrett and Stavins (2003)
[6] Finus (2006) show that free-rider incentives can be overcome to form stable coalitions if benefits from abatement are sufficiently high or with an appropriate transfer scheme.
[7] See MacKay (2009) appendix 1
[8] Articles 17, 6 and 12 respectively

i.e. where it is cheapest, and also allow for the diffusion of low carbon technologies to developing countries. This 'market mechanism' approach has been taken further through the introduction of a European Union Emissions Trading Scheme (EU ETS) in 2005 in order for the EU collectively to reach their commitment under Kyoto.[9] However, the EU ETS only covers around 50% of GHG emissions therefore significant domestic reductions will be required to meet the remainder.

The Copenhagen Accord was signed at the Conference of Parties in December 2009 in an attempt to provide a successor for the Kyoto Protocol, but this is not a UN agreement. Copenhagen has certainly placed more emphasis on the requirement of national commitments and schemes for tackling domestic reductions. The difficulty in achieving a stable consensus and agreement was shown here as national interests became the main obstacle to agreeing a treaty to which all parties approved. Copenhagen is seen as a failure by many for moving away from the UNFCCC Kyoto framework to a non-binding one. It is less inclusive with fewer nations agreeing on its details.

However, the Copenhagen Accord has provided a basis for agreement on long-term stabilisation levels and for setting national emissions reduction targets – though not with any specific overall framework and cap, like with Kyoto. The Copenhagen approach may well proceed more rapidly than the Kyoto-type process as it does not require acceptance from all UN countries for decisions to be passed. It is an opportunity for the major emitters to begin taking steps towards reduction. For the first time the USA and China, the two biggest GHG emitters, have signed up to an agreement on climate change, a step that was not achieved through Kyoto and is seen necessary if global emissions are to be reduced to the required level to stabilise temperatures. To some though this shows a lack of intent and is meaningless if the agreement is not binding.

Also Copenhagen has outlined commitment for transferring climate funds from developed to developing nations. These funds will assist both mitigation and adaptation. Some warming is inevitable. Consequent to increased emissions over the

[9] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003

last century, we have already seen the world mean temperature rise by 0.8^{o}C. Therefore there must also be decisions taken on an appropriate adaptation plan by each country. These will vary greatly as different countries' experiences of warming will differ by various factors such as geographical location and income levels.

Although market mechanisms are vital in achieving the necessary emissions reductions cost-effectively, Kyoto stresses that they have limitations which mean that it is still absolutely essential that each country takes responsibility for ensuring their own emission reductions through other measures such as taxes, technology support and information provision. It is also necessary that domestic emissions reductions take place to ensure developed economies become low-carbon in the long run, because developing countries cannot achieve the necessary abatement in the long term and also because developed countries are mostly responsible for historic emissions.[10] The Kyoto Protocol stresses the importance of domestic reductions and not completely relying on market mechanisms created by the protocol i.e. that there must be a balance between wider market mechanisms and domestic action because all countries will require to be low carbon in the future once cheaper abatement options have been exhausted.[11] This commitment to domestic reductions should provide the incentive for domestic investment in technologies required to achieve a low carbon future. For the reasons discussed above there is now a shifting consensus that domestic emissions reductions must play a large role in efforts to tackle global climate change. Domestic action can come in the form of pure regulation e.g. efficiency standards, and also market mechanisms such as a carbon tax or national emissions trading[12].

The UK government is introducing regulation and policies to encourage and enable movement towards a low-carbon economy. In doing this it hopes to show leadership

[10] Historical emissions have been a topic of major debate in international negotiations with developing nations laying the blame of climate change with developed countries. This is a moral question as to how the cost of global reductions should be spread.

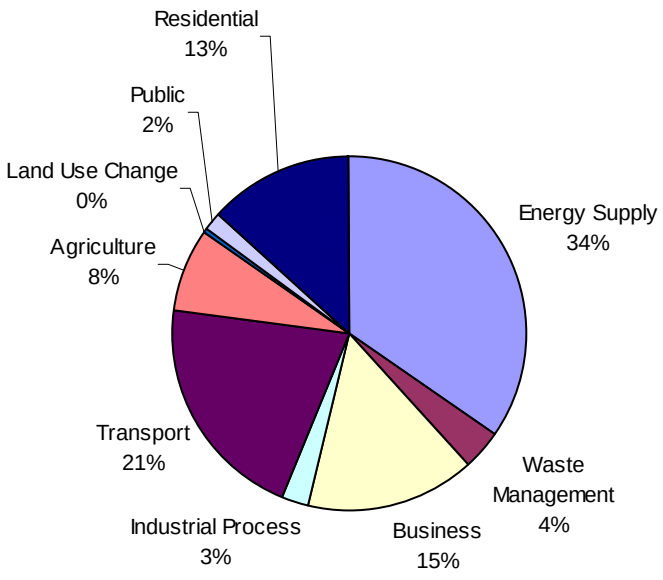
[11] Article 6(1) (d) and Article 17 of the Kyoto Protocol created Joint Implementation and Emissions Trading respectively and both stress that the flexible mechanisms are 'supplemental to domestic actions' in achieving the emissions reduction goals of the protocol. They do not specify the balance between these. The Clean Development mechanism created by Article 12 is in a similar vein in that any reductions must be 'additional' to reductions that would have otherwise happened anyway.

[12] The USA passed a Bill through Congress to create a national carbon trading scheme but was not able to get through the Senate, it is highly unlikely a US trading scheme will be introduced in the near future and a tax is now looking more likely. Japan and Australia are also considering steps to establish a cap and trade system. However, due to economies of scale, it may be more efficient for many national trading schemes to link-up. This is a lot easier to introduce than cross-border taxes or regulation.

on climate change, given the UK's historical role as an emitter, which will then inspire other countries to commit to reductions as well. "This leadership argument is best understood in game theory terms: it is an attempt to induce steps towards a global carbon cartel to reduce the quantity of emissions."[13] It also makes sense to introduce the necessary changes sooner rather than later, given that change will be costlier in the future if we are already locked-in to a high carbon economy, although this is dependent upon how future costs are discounted.

Total UK GHG emissions are mostly generated by energy, transport and business but there are also substantial emissions from the agriculture and residential sectors (**Figure 1**). Carbon dioxide is the largest GHG emitted, accounting for 85% of UK GHG emissions in 2008, while the other main gases are methane and nitrous oxide (quantified in carbon dioxide equivalent). Around 50% of UK GHG emissions are already covered by the EU ETS, mostly from the energy sector but also the mineral and paper industries.

Figure 1: UK GHG emissions data 2008



Source: DECC statistics

[13] Helm (2007c)

The current UK energy institutional arrangements are is already rather complicated. Helm (2007a) suggests that the UK has a new energy paradigm. He notes that the energy institutional setup is geared towards the market settings of the 1980s and 90s but that new policy emphasis on climate change and security of supply is not represented within this. The institutional arrangements require radical reform to meet these new challenges. There are energy related institutions, such as the regulator Ofgem, which have been present for some time and the government has recently created new institutions, such as the Carbon Trust, and instruments, such as the Climate Change Levy (CCL) and Renewable Obligation certificates (ROCs). It seems so far that these additional institutions have been *ad hoc* at best, adding to an already complex structure for industry and investors.

However, climate change must be viewed as one goal within energy policy as a whole and, indeed, government policy more generally. There are other government energy policy goals, such as security of supply and affordable energy prices, which are interdependent both with each other and any environmental goal.[14] More generally there is a possible conflict between pursuing the objectives of continuing economic and population growth, while simultaneously seeking to reduce emissions.

[14] The Scottish Government also has a further goal of using energy as a source of economic growth by promoting renewable energy sources

Table 1: UK main Energy and climate change institutions overview

Institution	**Purpose**	**Type**	**Start date**	**Funded by**
Ofgem	Regulates the gas and electricity markets	NDPB	2000 (merger of two existing bodies)	The various energy suppliers that Ofgem regulates
Energy Saving Trust	Provides free, impartial advice and information for those interested in saving energy	Independent organisation	1993	DECC, DEFRA, DfT, devloved governments and private sector e.g. EDF Energy
Carbon Trust	Helps companies and organisations to lower carbon emissions and funds low carbon technologies	Company	2001	DECC and partly by the Climate Change Levy
Sustainable Development Commission	Provides independent advice to government on sustainable development	NDPB	2000	Various government departments
Nuclear Decommissioning Agency	Clean up UK's nuclear legacy in a safe and effective manner	NDPB	2004	DECC, HM Treasury and devolved governments
Committee on Climate Change	To advise and monitor government progress towards emissions reduction targets	NDPB and statutory body	2008	DECC

In addition to this already complicated institutional setup the government has initiated a major new institutional change with the creation of a climate-change-specific body, the Committee on Climate Change (CCC). This is an independent body, introduced through the Climate Change Act (2008), tasked with determining the emission reduction targets and carbon budgets that the UK government should set. The CCC is the first environmental body of its kind. It is seemingly inspired by the model of the Monetary Policy Committee (MPC) of the Bank of England, although it is charged with many extra considerations, while operating in a field with many other energy related institutions. Therefore it is appropriate to analyse the purpose, structure, and role of such a body and consider specifically what it adds to the policy mix.

Also, there are potential tensions between the CCC carbon budgets and other policies on different spatial scales, be they national, regional or international. It must be noted that there are large areas of overlap between international environmental agreements and domestic action, and the extent to which these policies and instruments reinforce or undermine each other is worth detailed comment. In particular, the concept of having national emissions targets, efficiency improvement targets, and renewable policies simultaneously with the EU ETS seems, in theory at least, inefficient because multiple policies only lead to higher costs. This is unless some extra benefits are brought from having additional policies such as improving efficiency by overcoming market failures or delivering other social objectives, such as security of supply, distributional considerations or political feasibility (Sorrell and Sijm, 2003). If this is what Kyoto seems to suggest, it is necessary to discuss what these benefits are and what issues arise from multiple objectives.

Section 2 is a discussion of a range of possible motives for delegation of carbon policy to an independent body. In each case we discuss what institutional setup would be suitable and what other alternatives may be available. Section 3 of the paper describes the CCC's structure, functions and its tasks. Section 4 identifies what we believe, given the preceding analysis, to be the reasons for the creation of the CCC and its main roles. This involves a comparison of the CCC with the MPC. We suggest that, in light of its current structure, the CCC is in practice better viewed as playing a 'Rolling Stern plus' role due to its advisory and monitoring functions, rather than being directly comparable to the MPC. Section 5 provides an evaluation of the CCC which includes a discussion of the setting of budgets, 'extra considerations', monitoring functions and how domestic carbon budgets interact with the institutions and instruments on various spatial levels e.g. EU ETS and renewables targets. Section 6 then concludes.

2. REASONS FOR DELEGATION TO AN INDEPENDENT BODY

In order to achieve their policy goals, governments have a number of possible options. Examples are command and control regulation, market mechanisms or institutional

changes. One such option is to create a separate body, independent from government, which is given specific roles or powers – essentially removing the issue from the political process. Such an independent body can take many possible forms, depending on its purpose.

In this section we begin by identifying a number of possible purposes for which an independent climate change body could be created. We discuss the appropriate composition of such a body and outline the policy levers that would seem appropriate to give the body in each case. The potential purposes we consider are: information provision; advisory role; monitoring function, and policy delegation. Of course an independent body could, in practice, combine a number of these roles.

(2.1) Information provision

Accurate and timely information on climate change is necessary for all relevant parties. Information and evidence on updated science and emissions data at a national, industry or company level are all needed for accurate analysis and to inform both public and private sector decision-making. The government may wish to enhance the credibility of the climate change information by delegating the responsibility for gathering and distributing such data to an independent agency. This is a possible consideration because statistics coming directly from government may be manipulated for political purposes. A recent example of such delegation is the Office of National Statistics (ONS), which became independent from government in 2007 in order to enhance the credibility of the data that it publishes. Since this independence there have been issues over communication of data and, on occasions, undue pressure has been placed upon ONS staff from government departments. In December 2008, the Home Office released statistics on knife crime early, against the advice of the ONS who suggested that the data could easily be incorrectly interpreted. This political interference was heavily commented upon by the media and senior government officials, and resulted in a public apology by the Home Office (BBC News, 2008b). Clearly, ceteris paribus, the independence of the statistical body increases the credibility of information provided, given that when under direct government control, manipulation could, and has, occurred.

A similar motivation as with the ONS could be behind a delegation in climate change as the same argument on information credibility could easily be applied to the provision of climate change or energy related information. This information may be in the form of scientific evidence, statistics or advice from independent experts.

An independent body adds credibility because the information comes from an autonomous source rather than direct from government. The government could quite easily undertake this role and provide the information itself but the public may be sceptical of the resultant data because they anticipate a degree of political manipulation with regards to the accuracy, comprehensiveness and/or timing of information being released (see *Political Pandering* below for a fuller discussion). This could lead many pressure groups, such as energy suppliers/users and environmental campaigners, to question the validity of official data and issue rival statistics in order to challenge government figures. This in turn may lead to the saturation of public information on climate change and cause considerable confusion. Voters become unsure who to believe and this can be frustrating, leading to considerable apathy on the issue. Therefore an independent body may appease stakeholders and be agreeable to all concerned as a main supplier of reliable information. The public may also be more likely to accept the sometimes negative consequences of combating climate change and to take action to curtail their carbon footprint because they believe in the validity of the statistics and the credibility of the agency. MacKay (2009) stresses the importance of using clear figures and advice to the public concerning what they can actually do to lower their carbon use in the most efficient and meaningful way. If demand for energy use is to be substantially reduced through lifestyle and consumption changes over time, this may be best achieved through a central climate change information body.

A climate change information body of this type should have a similar structure and setup as the ONS. This would consist mainly of a staff of scientists, statisticians and economists who can collate climate change information centrally and disseminate it in a simple manner for government and public consumption. Some of this work is currently done by the Carbon Trust, an independent body which works to improve energy efficiency in the public sector and businesses and to promote investment in renewable energy technology.

(2.2) Advisory Body

Another possible reason for the creation of an independent climate change body would be to provide unbiased scientific advice to the UK government on climate change issues. Advisory bodies of this nature are common-place in government in the form of Quangos or non-departmental public bodies (NDPB), as they are now called. As of March 2008 there were officially 410 UK advisory NDPBs, 41 within DEFRA. Examples include the Sustainable Development Commission and the Royal Commission on Environmental Pollution (as well as the CCC).[15] Similar bodies also have a role in the private sector, often going under such names as: advisory board, committee, council or authority, where organisations feel they benefit from input from experts out-with their own organisation who can give a fresh or experienced perspective. A further example is The Scottish Council for Development and Industry.

The government would have to make a decision on the exact remit of such a climate change advisory body in order to determine what precisely it is supposed to advise on, as such a body might have a range of possible functions. This remit could be as explicit as necessary. It may relate to one specific aspect e.g. advise precisely on how to lower emissions from transport. On the other hand, it may be more general, focussing on the science of climate change or it may also incorporate social or economic aspects. However, especially given the range of issues involved in climate change, it is advisable not to have too limited a remit, as this may be to the detriment of another important area. This is then a question of getting a balance between the remit of the body and existing bodies in terms of overlap. You do not want to miss out on important policy areas but also it would be inefficient for significant overlap.

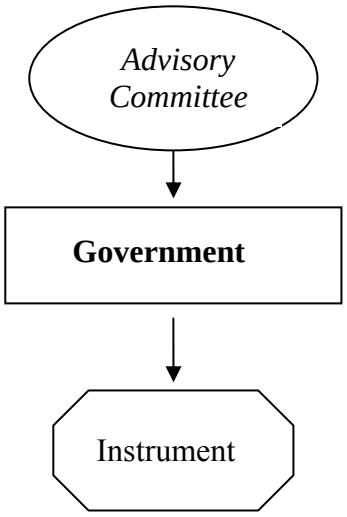
In general how successful a body will be is significantly determined by its members' expertise, and the greater this is, the more detailed its advice can be and this should maximise the quality of the relevant information set available to government for decision making. This expertise however must be backed up by sufficient technical support to produce detailed analysis. This is especially important in climate change due to its complex interdisciplinary nature. Therefore appointing the appropriate

[15] See Cabinet Office (2008) for a full list.

individuals in the first place is critical in gaining the largest benefits from the creation of an advisory body on climate change. A climate change advisory body would therefore not have any members representing the ordinary public but be comprised entirely of experts in the field of climate change, from various backgrounds.

A climate change advisory body could inform government, providing it with expert advice on the level of emissions reductions needed to move the UK to a low carbon economy. This advice could also go further to include a breakdown of where exactly emissions occur, where they could be most easily reduced and advice on the specifics of available policy options. A softer advisory body could be seen purely as a source of data and statistics (see section 2.1 above) for government to make informed decisions about policies on climate change, similar to the independent Office of National Statistics, but combined with advising the government on specific technical issues. A tougher advisory body would advise on a wide-range of areas in great detail and probably combine its advisory capacity with other roles.

The advice given could be used to set and/or implement emission reduction targets. The government can choose to implement these actions itself or delegate the responsibility of achieving targets to another separate body by giving it control of a policy instrument or lever.



Stern (2006) emphasises the important international aspects of tackling climate change. So such an advisory body would preferably provide advice at international, national and regional levels. It could inform domestic policy on climate change and also the UK's role in international climate change agreements.

(2.3) Monitoring

An independent body could also play a purely monitoring role. In this case, the government or another body would set the goals e.g. emissions reduction target, the government (or separate body) would attempt to achieve these goals. Afterwards the monitoring body would judge whether these objectives had been achieved, whether through a quantitative or qualitative analysis or both. Given the nature of the problem this would likely involve monitoring whether reduction targets are being specifically met. This work would entail assessing whether goals were being achieved in a timely manner and done to a sufficient level of precision. The findings would be public knowledge, available for further scrutiny and comment. This process would be repeated on a regular basis. Such a monitoring body would investigate the results the government believes it has achieved, and therefore its independence must be absolute (see *Political Pandering* below for a discussion on the requirement of delegated body members' independence). Access to information and a high level of transparency are necessary within the monitoring process to allow accurate and credible reporting. Access to information will require detailed data on both the public and private sector, and on projects aimed at cutting emissions. Transparency is critical in the success of any monitoring body. Only through such an open process can the electorate have confidence in the monitoring process. If there is any ambiguity with regards to the information then credibility may be lost.

An effective monitoring body would also have the power of sanctions in order to deter non-compliance by the government or the body tasked with achieving the previously set goals. It may be very difficult to achieve a credible sanction because financial or legal penalties cannot be easily imposed. However some sort of public embarrassment or "shaming" may be appropriate as a possible sanction. A further possible sanction option would be a legal challenge to individual decisions or non-compliance with legally binding emissions reduction targets. (These legal issues are discussed further in *Setting Carbon Budgets*)

Whether the imposition of sanctions is automatic or not is also relevant here: if left to the monitoring body's discretion, this could result in inconsistent outcomes and varying degrees of severity i.e. the monitoring body has authority over whether, and

to what degree, the government has met targets and also sets the level of any imposed penalty. A number of sanction options may be appropriate on a case-by-case basis, although consistent application of agreed criteria for determining the sanction would be critical. In monetary policy a sanction exists where a letter must be sent by the Governor of the Bank of England to the Chancellor of the Exchequer if inflation deviates too far from its intended rate, this is intended to work as a form of embarrassment but also as a means of publicly explaining why such a deviation has occurred and what response is planned. Although not severe, this rule does provide for consistent transparency in the monitoring process by requiring a public response to targets not being met. If this sanction were to occur regularly then perhaps the position of the Governor or the MPC members may be questioned.

A monitoring body would likely comprise officials who have the ability to check in-depth whether targets have been achieved by government. Most likely, a good knowledge of climate change science and policy would be essential in order to interpret details and make the monitoring process more credibly robust. These individuals would most likely be highly regarded figures of integrity, whose independence is beyond doubt in order to achieve the necessary credibility. The monitoring body could be anywhere between being simply a purely numerical independent review and verification of government figures, to commenting upon whether government targets are being met and requesting a response where they are not, or even imposing sanctions where available. As carbon policy incorporates many diverse sectors of the economy it is not possible to have a regulator in the same way as happens in financial markets or even gas and electricity markets, due to their disperse nature.

(2.4) Policy Making

The government may delegate actual policy or decision making to an independent body for a variety of reasons, which are outlined below.

2.4.1) Political pandering

The government may delegate decision making powers to an independent climate change body in order to remove the ability of the government to manipulate policy for other political purposes. This motivation is similar to that for independent information provision but in this instance the devolved body has decision making powers rather

than simply an information provision role. Even without any intertemporal aspect or comparison to the MPC (this is developed further below in *Time Inconsistency*) delegation may be efficient and provide benefits. Political pandering occurs where an incumbent government, faced with re-election, chooses policies that will appeal to the public in order to improve their chances of being elected again, in essence, pandering to voters regardless of whether voters' beliefs are correct or welfare enhancing. This assumes, realistically, that most voters have incomplete information and little incentive to investigate all policies in detail, so the role of government in this case should not necessarily be to follow voters' wishes but rather to act in the voters' best interests, on occasions when they have a more accurate information set. However, it also assumes that government is motivated almost wholly by re-election and this incentive can often be in direct contradiction to acting in the voters' best interest. Therefore there are occasions where allowing decision making by politically accountable officials may result in the setting of a suboptimal policy outcome purely for political gain. Removal of policy making in sensitive areas to independent experts can have beneficial welfare effects especially where the public are less well-informed. Maskin and Tirole (2004) suggest that "technical decisions, in particular, may be best allocated to judges or appointed bureaucrats"[16] but that discretion should be limited in such cases and Helm *et al* (2003, p439) says specifically in the context of carbon policy that delegation "reduces the possibility that governments, driven by the next election and other short-term political economy considerations, will set carbon policy inappropriately."

In order to bypass any political pandering an independent climate change committee would have powers to make decisions which public opinion may not always favour. In practice it is highly unlikely there will be the degree of political will required to allow delegation of full decision making. For instance serious carbon reductions may require substantial increases in fuel prices, but it is certain that a tough fuel price accelerator, for example, would not be popular with the public.[17] Therefore the government (principal) would not be willing to allow this degree of power to be delegated out-with its own control (to an agent). The catch twenty-two is that

[16] Maskin and Tirole (2004)
[17] For an example see the effect of industrial action by heavy vehicle drivers on fuel prices in 2008 (BBC, 2008a)

delegation is a good option for government where policy is likely to be unpopular because it means the public cannot blame them for any perceived negative consequences of the decision, but by delegating the government loses control of important decision making powers, the government may end up in a worse-off position than it would have been has it retained control and made the decision itself.

Delegation also has close links with regulatory capture theory (Stigler, 1971) where companies in heavily regulated industries e.g. energy, use their proximity to regulators to influence or manipulate the government in order to limit new entrants and retain market power. This is really a specific case of political pandering, where government is pressured into making politically beneficial decisions for a specific industry, rather than the whole electorate. In return the government may receive political backing in the future. Basically there are rents from regulation and policy which existing firms will try to capture. In order to bypass this possibility a government may delegate regulation to an independent body that has less possibility of being influenced by the private sector. Helm (2007a, p33) states as much with regards to regulatory capture and political pandering:
"The design of institutions which can provide policy credibility to private investors has been a major preoccupation in Britain in the regulation of privatised industries and in monetary policy. The main requirements are to minimise the scope for capture by regulatees and prevent intervention based on short-term political considerations. These aims are best achieved through an element of statutory independence with an associated emphasis on technical expertise. Independence gives the formal separation of functions, while expertise enables the regulatory body to build up reputation."

It is necessary however to distinguish between political capture and general regulatory capture which could still occur i.e. some capture of independent bodies may still take place. Whether this happens depends on the incentives of the members of the delegated body. If they are truly independent and their incentives cannot be unduly influenced by industry then it is possible to escape from inefficient regulation. The composition of an independent body with policy making powers is therefore of the utmost importance to its success and this applies to all of the motivations for delegation that have been mentioned, not only avoiding political pandering. The purpose of a body will surely influence the composition of its members e.g. a

conservative central banker regulating monetary policy when the requirement is monetary prudence. More generally, for any type of delegation, if it is a purely technical body then scientists should be appointed, likewise if business orientated then those with business knowledge and experience must play an important role. A balance has to be struck between types of members appointed to a body in order for there to be a fair, well-rounded outcome that has input from people with quality but varying expertise. This diversity will give the body more scope and range in its conclusions, which may be beneficial but depends upon its objective. In this specific case, it is likely that the composition would be diverse in terms of fields of study given the complex and interdisciplinary nature of climate change.

Capture theory may also be more applicable if an independent body, through constant contact, becomes increasingly aligned with industry. The high frequency of the interaction a body has with industry, and a greater understanding of the industry's problems, may well lead such a body gradually to become more sympathetic towards the industry.

There is obviously some alignment of incentives required for the CCC to act in accordance with government's wishes because the body is being given a direct task by government, but the extent to which such bodies are independent in this principal-agent relationship depends on their composition. Committee member's incentives must not be completely aligned with those who delegate in the first place, otherwise the delegation is worthless as no-one will believe that the body is genuinely independent. However, most importantly, members' interests must be congruent with government in terms of commitment to the climate change issue. Perhaps, in order to incentivise properly, performance related pay, i.e. bonuses for hitting targets set by government, could be implemented for members of a committee with delegated policy powers.

2.4.2) Time Inconsistency

In environmental policy there is a time inconsistency problem that arises when attempting to reduce emissions and this appears to have been a major consideration leading to the creation of an independent climate change body. Significant reductions

in emissions require considerable irreversible private sector investment which in turn depends on knowledge of long-term government carbon policy and other energy policies. For example, if it is expected that carbon emissions will be taxed heavily in the long-term or that a permit trading system will be in place, then investment in renewables will increase as they become more cost competitive. The tax or permit system will raise the marginal costs of dirtier energy sources and make investment in cleaner sources more attractive to investors. However, if there are issues about certainty of the tax then a time inconsistency problem may occur as follows: Firstly, government sets the tax/permit level for emissions and then secondly, the private sector responds accordingly by increasing investment in renewables and energy efficiency measures. However thirdly, after the sunk investment from the private sector, the government may have an incentive to backtrack on their carbon policy *ex-post* for their own political benefits e.g. lowering carbon taxes or increasing tradable permits to stimulate output, enhance competitiveness, reduce energy prices or alleviate fuel poverty. Investor's expectations incorporate this and they therefore believe that the government will renege on its promises, and so under-invest in the necessary low-carbon technologies. This is the time inconsistency problem and it occurs because governments face multiple goals in a short lived time frame i.e. their carbon policy is not credible.[18] In essence this is a quandary caused by the political process and also the multiple and often conflicting policy goals.

The time inconsistency problem arises from the fact that the policy maker has discretion, but if the policy maker can somehow commit to pre-determined tax rates (most likely increasing in robustness over time), perhaps through the use of a promise or contract, then the time inconsistency problem can be circumvented. Therefore it is necessary to give investors credible expectations on future policy in order to induce the required investment but how can this be achieved? Helm *et al* (2003) summarises the time inconsistency problem in a non-technical manner and suggests that it could, at least partially, be solved through the delegation of carbon policy to an independent energy agency. They set out a model in which welfare is maximised when the government can credibly commit to a policy rather than under discretion. The rationale behind this energy agency is that a long-lived independent institution can

[18] The government face multiple goals at the same time but once industry has invested in a technology, the governments trade-off may change

influence the expectations of investors through reputation. Helm *et al* (2003) argues that if the independent agency can sustain a credible reputation, then it should be delegated the social welfare function to optimise. Theoretically this would involve the government outlining society's goals (e.g. setting weights on increasing output and reducing unemployment and emissions) and delegating responsibility for maximising the welfare function to the body which controls a number of policy instruments. In the absence of reputation the body may be delegated a single policy instrument, similar to the MPC, or a modified welfare function, akin to that of a conservative central banker. Helm *et al* (2003) also presents the option of an agency with no policy instrument, which only monitors government performance and provides recommendations meeting the targets where necessary. Such a body would "increase transparency and hence credibility, but not be wholly convincing"[19] and this is the outcome that Helm believed was the most likely for the UK.

A full model solving time inconsistency in carbon policy is outlined fully in Helm *et al* (2004).[20] A model of industry and government interaction in the production of energy is set out and solved for the cases of government discretion and commitment in exactly the same manner as below.

Firms

Energy demand, Q, has constant price elasticity:

$$Q = \alpha P^{-\varepsilon} \tag{1}$$

Where P is an index of energy prices, $\varepsilon > 0$ is the price elasticity of demand and $\alpha > 0$ is a constant. In this model price equals average cost.

Emissions, E, are a linear function of energy output:

$$E = eQ \tag{2}$$

[19] Helm et al (2003) p446

[20] D'Artigues et al (2007) also solve a similar time-inconsistency model but involving only two possible technology choices and the possibility of renewable subsidies through negative tax rates.

$e \in (0, e_D)$ is a dirtiness parameter and the emissions per unit output of the dirtiest technology is e_D, whose cost of production is lowest at c_D. There is a set of possible production sets with the dirtiness parameter, e and production costs, c, inversely related to each other.

(3) $$e \geq \beta c^{-\sigma}$$

The above condition must hold, where σ is an elasticity parameter and $\beta = e_D c^{\sigma}_D$, so that the firm with dirtiest technology has the lowest emissions and cost combination. Total costs for industry are cQ.

Government has a carbon tax, t, as its policy instrument and thus with identical firms, total average costs are $c + te$.

Assuming there is Cournot competition with free entry, then entry will continue until price equals average cost. Given this market form, firms place themselves on the technology possibility set where expected costs are minimised, $c + E[t]e$, subject to $e \geq \beta c^{-\sigma}$. Where $E[t]$ is the expected tax rate on emissions.

Optimal cost and emissions choices for a given carbon tax are:

(4) $$c(E\{t\}) = \max [c_D, (\sigma\beta E\{t\})^{1/1+\sigma}]$$

(5) $$e(E\{t\}) = \min [e_D, \beta(\sigma\beta E\{t\})^{-\sigma/1+\sigma}]$$

For a particular technology choice of cost and dirtiness (ċ, ė), the relationship between prices and emissions can be parameterised by the tax rate, t. From first two equations:

(6) $$E(t) = \dot{e}dP(t)^{-\varepsilon}$$

When firms can choose technologies i.e. not fixed, and therefore respond endogenously to the tax rate, increasing t will inevitably lead to investment in clean technologies. So this relationship becomes:

(7) $$E(t) = e(t)dP(t)^{-\varepsilon}$$

Where $e(t)$ is given by ($e(E\{t\})$ above - equation (5). Assuming expectations are fulfilled such that E[t] = t, substituting equation (5) into (7) gives the relationship between prices and emissions.

Welfare

The welfare function in the model consists of: change in consumer surplus s(P); tax revenues r = *t*E; and disutility from pollution *z*(E).

(8) $$\omega = s(P) + \nu r - \lambda z(E)$$

Where λ is the weight on pollution and ν is the marginal benefit of public funds from the emissions tax, both measured relative to consumer surplus. For an isoelastic demand curve, the change in consumer surplus relative to a given baseline price level P_D is given by:

(9) $$s(P) = \alpha/1-\varepsilon \, [P_D^{1-\varepsilon} - P^{1-\varepsilon}]$$

And with a simple specification of disutility of emissions (where $\gamma > 0$) as

(10) $$z(E) = E^{\gamma}$$

We can describe welfare as a function of tax:

(11) $$\omega(t) = \alpha/1-\varepsilon \, [P_D^{1-\varepsilon} - P^{1-\varepsilon}] + \nu t E(t) - \lambda E(t)^{\gamma}$$

Solution under discretion

When government retains discretion to alter the tax rate *ex post*, a dynamic game of complete information is played in the following order: (1) the private sector forms their expectation of the tax rate E[t] and thus chooses their optimal (*c*, *e*); then (2) the government chooses the tax rate *t* given the firms' technology choice. Solving by backwards induction, the government reaction function, t(c), is given by the solution to the first order condition:

(12) $$\left.\frac{d\omega}{dt}\right| = 0$$

i.e. The policymaker chooses the carbon tax which maximises its welfare function for a fixed technology choice. There exists a unique interior discretion solution (t', c', e')

Solution under commitment

When government can commit to a tax rate, there is another dynamic game of complete information. This moves sequentially: (1) The government announces and commits to a carbon tax rate *t*; and (2) the private sector forms expectations of the tax rate, with E[*t*] = *t* under commitment, and so makes technology choice (*c*, *e*).

This is solved by backwards induction. For a given carbon tax, the private sector costs and emissions are simply c(t) and e(t) in equations (4) and (5). The policy maker knows the reaction curve and sets the carbon tax to maximise the welfare function in equation (8). The first order condition for the policymaker is therefore:

(13) $$\left.\frac{d\omega}{dt}\right| = \frac{\partial \omega}{\partial t} + \frac{\partial \omega}{\partial c}\frac{dc}{dt} + \frac{\partial \omega}{\partial e}\frac{de}{dt} = 0$$

From which there is an optimal tax rate t^*, from which the technology choices are given by substituting into equations (4) and (5). There exists a unique interior commitment solution (t^*, c^*, e^*) as the welfare function is concave and the firm reaction function is convex.

Conclusion

These solutions of discretion and commitment produce different outcomes on most occasions because "the marginal effect of the tax is different before and after technology choice".[21] The elasticity of damage to emissions is lower after investment; however tax revenues are more responsive to the tax rate after investment. Therefore the time inconsistency problem depends upon which is most prevalent – the changed elasticity of emissions or tax revenues. Helm *et al* (2004) proposes that this is dependent upon the value of ν, the marginal cost of public funds. If ν = 1 then the optimal tax is the marginal damage from emissions and both discretion and commitment solutions are equal. If ν > 1 then taxes are lower under commitment than discretion i.e. an *ex post* incentive to raise taxes, and vice versa for ν < 1. In practice it is not clear what value ν would take and this will be affected by a variety of considerations such as how distortionary the emissions tax is, how it reduces distortions in other taxes, distributional concerns and political economy factors. If a combination of these results in ν < 1, then discretion is not conducive to achieving credibility and therefore under-investment in low carbon technologies will occur. Helm *et al* (2004) show that an additional policy instrument, in the form of an output subsidy, does not solve the problem under discretion and suggest institutional reform as a solution in the form of an independent energy agency. The model does seem a little over simplistic in so far as to suggest that a solution is completely dependent upon the marginal cost of public funds.

[21] Helm et al, (2004) p9

Three possible forms of delegation are suggested as a solution to time inconsistency in this instance; (a) delegation of the true social welfare function, when reputation can be established and held, (b) an authority is given an instrument in order to achieve a single specific objective e.g. akin to the MPC, and (c) discretion given to an environmental policymaker that has a different weighting on emissions reduction, $\lambda \neq \lambda$, than that of society e.g. akin to the conservative central banker,.

There are many other areas of economics where problems of time inconsistency and credibility occur. The best known, classic, example is in monetary policy. Here a time inconsistency problem occurs because often government wishes to renege on low inflation promises for short term political gain by stimulating economic activity through cutting interest rates. However the public fully expects this and all the government achieves is larger than necessary inflation, an outcome that is generally labelled 'Inflation bias' (Barro and Gordon, 1983).[22] There are many possible solutions to this problem including committing to a rule, appointing a conservative central banker (Rogoff, 1985) or using an incentive contract (Walsh, 1995).[23]

In the case of monetary policy in the UK it is the Monetary Policy Committee (MPC) of the Bank of England, established in 1997 with a main remit of maintaining price stability. The MPC sets interest rates independently to achieve a government-determined inflation target, currently two percent. In this case we have so-called 'instrument independence' because there are two distinct bodies, one which sets the goal (government) and an independent body (MPC) tasked with carrying out the goal using a single policy instrument (the interest rate). The nine member committee publishes all of its monthly meeting minutes and has strict rules regarding how decisions are taken. These features create credibility and transparency to influence inflationary expectations where a time inconsistency problem would otherwise arise. In practice the MPC sets the interest rate as an instrument to indirectly control inflation and the public's inflationary expectations. This has generally been seen as a success in the UK since its commencement in 1997 until the recent recession which begun in late 2008. Therefore, for obvious reasons, the MPC solution tends to be viewed as a baseline against which other time inconsistency problems can be

[22] For a textbook analysis see Walsh (2003)
[23] See Kydland and Prescott (1977) on rules rather than discretion in general

compared. This can be seen as providing a good argument for an independent climate change body that has an emissions tax as an instrument.

The monetary policy framework provides a remit for the MPC to a) maintain price stability; and b) subject to that, to support the economic policy of the government. Theoretically this could be construed as maximisation of a lexicographic welfare function, where the inflation rate is the first target and once achieved, the second task is the growth and employment rates. However, recent economic circumstances have shown that it is not always possible for the MPC to concentrate solely on influencing inflation expectations, especially when there is perceived to be a significant and serious threat to the real economy, and this is acknowledged in the monetary policy framework. In severe economic circumstances the MPC can cut interest rates in an attempt to stop deflation and also help stimulate spending when output drops substantially. Getting a consistent balance between the goals of inflation targeting and higher output levels is challenging. Recent events may well therefore affect the credibility of the MPC on inflation targeting, which will have to be re-earned over time, and so the MPC is probably less able to influence public inflationary expectations than before, an outcome that will remain until this credibility and belief that the MPC is committed to, and capable of, controlling inflation is regained over a period of relative stability in the economy.

Although an analysis of current UK monetary policy is not the purpose of this paper, some further discussion aids our comparison with climate change policy and may give insight into future problems which could arise. The recent recession is the first time that the MPC has had to operate under such turbulent economic conditions. How exactly do these conditions affect the normal transmission mechanism, and is it only a temporary shift from business as usual? This raises the possibility that the MPC may have two separate functions and may work differently under distinct economic conditions. This is hinted at in the MPC remit, which states that it is responsible for hitting the government inflation target and subject to that, to also promote government economic policy of growth and employment.

The first function is under stable economic conditions, where the MPC is solely tasked with achieving price stability through the setting of interest rates to minimise

variations of inflation around a two percent target. Here the task of supporting government economic policy on growth and employment is always secondary.

The second function, under difficult economic conditions, would be as a direct arm of government when the economy is subject to major shocks, while still keeping the objective of meeting the inflation target. Basically here the second objective, of supporting economic policy, may increase significantly in importance, especially when faced with the impending collapse of the financial system. However, it does not seem that the time inconsistency problem is always being solved if both objectives change in importance. This suggests that the theoretical removal of monetary policy from the political sphere is not entirely possible in practice: circumstances in which monetary policy has to adjust to avoid disaster in the real economy. This is not to diminish the success or benefits of the MPC but merely to suggest that it is not possible to sustain inflation goals in exceptional circumstances.

It is likely that, while the MPC is still attempting to control inflation, the transmission mechanism to do so does not function in the same way under difficult economic conditions. We can see this from the major adjustments in interest rates down to half a percent in March 2009. Inflationary expectations may have become more volatile or do not respond in the same manner as before. This might be due to a perceived change in what the interest rate is being used for, or in how other factors influence inflationary expectations. It is likely that this is only a temporary deviation and that the role of the base interest rate to, first and foremost, control inflation will eventually be reinstated. This is not the only extreme measure or deviation from the norm; we have seen quantitative easing used for the first time in the UK as a method for stimulating economic activity. The MPC took this step even though it increased the probability of missing the inflation target because they have been more concerned with the larger long-term ramifications of a possible collapse of the financial sector. The Monetary Policy framework does allow for government to instruct the setting of interest rates in extreme circumstances through other legislation; however this power has never been used. As for why it has never been used; perhaps the MPC has always anticipated its use by government and decided that it is better for the MPC to change its priorities, from setting interest rates for price stability to, instead, stimulating the economy, rather than letting the government take over. If the government was to use

this power it would risk losing the credibility the MPC has acquired as a body. Therefore the question comes down to whether in a crises it is best for the MPC or the government to have control of an instrument which can help boost the economy.

Returning to climate change, a possible solution to the carbon policy time inconsistency problem would therefore be an independent body with a policy instrument similar to that of the MPC. The most likely and effective instrument would be the control of a price instrument in the form of a fiscally neutral carbon tax, which the body can alter to achieve the desired emission reduction target. An alternative would be a quantity based mechanism, such as emissions trading, as this would also raise fiscal revenue if allowances are wholly auctioned.[24] The fiscal neutrality of a tax or auctioned allowances is important in minimising distortions with government macroeconomic management (Pearce, 1991). Although in theory taxes would seem the better option with climate change due to steep marginal abatement curves and relatively flat marginal benefits, in practice quantity mechanisms such as emissions trading have proven more popular.[25] This preference for quantity mechanisms is due to political and industry acceptance of permits over taxes, in part explained by the use of grandfathering as a method of issuing emissions allowances, especially if some or all permits are distributed for free, therefore essentially a one-off subsidy to existing industries. Also given that an aggregate emissions cap is necessary in climate change, quantity mechanisms make sense. If applied to tackle climate change, a carbon tax would quite definitely directly affect emissions expectations by incorporating carbon emissions into decisions with price certainty. In times of comparative tranquillity it may function similarly to the MPC as its commitment to a low carbon economy will be credible. However such a body may wish to alter this tax rate in times of economic turbulence if it has other considerations beyond tackling climate change or if updated science suggests changing emissions reductions targets. However, by ensuring that any such tax is fiscally neutral, variations in its level will, to a first approximation, not affect aggregate demand. To ensure fiscal neutrality is difficult however without the

[24] The implications of such a framework could be explored through further work with dynamic computable general equilibrium modelling.
[25] The relative merits of price versus quantity instruments are outlined in Weitzman (1974). Benefits of price instruments has had extensive coverage in the literature on climate change market mechanisms, see Newell and Pizer (2003)

introduction of some monitoring of government decisions and in practice such taxes are rarely hypothecated in such a straightforward manner.

Helm and Hepburn (2007) also propose another possible solution to the time inconsistency issue. They suggest that long term carbon contracts could be used to move the risk involved in paying for reductions from investors to government, who are better placed to handle the risk, thereby lowering the cost of capital. This solution is perhaps analogous to the 'optimal contract' solution in monetary policy provided by Walsh (1995). It involves the government auctioning off long-term contracts to private companies, to provide certain amounts of future emissions reductions. This is only paid out on completion of the stipulated reduction being fulfilled. Essentially companies bid prices for specific emissions reduction levels, and the government then contracts with the company who can provide the reduction at least cost. This provides the long-run credibility, and carbon price certainty, needed over the life-cycle of investments in low-carbon technologies. This method also has an advantage over a carbon tax in that "the auction for carbon reductions creates property rights which it will be very hard for subsequent politicians to unwind". [26] It allows flexibility in that the government can auction any amount of its total domestic emissions reduction target i.e. it does not have to auction the whole reduction it's trying to achieve. An extra benefit of this method is that it clearly avoids the government "picking winners" in terms of technology adoption; it simply allows the market to choose the most efficient production mix. There are many specifics of the auctions which would have to be decided upon however, such as; who can bid, frequency of auctions and what type of auction is used.

3. COMPOSITION AND ROLE OF THE CCC

The Climate Change Act was given royal assent in December 2008. It provides for the creation of an independent, non-governmental body on climate change.[27] The CCC can have between 5 and 8 members plus a chair and chief executive to oversee its

[26] Helm (2007b) p.13

[27] The Act also merged departments within DEFRA and BERR to form the Department of Energy and Climate Change (DECC) whose Secretary of State is responsible for the CCC. However the CCC does not replace any existing government created institutions such as Ofgem, but rather adds to the energy and environmental policy mix.

running. Committee members are experts in the fields of climate change science, policy, economics and technology. Currently these are Lord Adair Turner (Chair), David Kennedy (Chief Executive), Dr Samuel Fankhauser, Professor Michael Grubb, Professor Sir Brian Hoskins, Professor Julia King, Professor Lord May and Professor Jim Skea. All of whom are appointed by the Secretary of State for Energy and Climate Change. These experts, mostly from an academic background, work to provide in-depth analysis and make decisions on climate change issues with a view to proposing the necessary steps to achieve a low-carbon UK economy. However, although they do detail specific policies available to achieve reductions in certain sectors, it is not within their remit to suggest the best policy approach to take; this is left to government. Obviously there is a need to have experts from different fields relating to climate change to gain the best perspective on how to tackle the problem and, given the wide-ranging considerations of the Committee (see below on *extra considerations*), it is absolutely necessary to have members with a range of knowledge and expertise. The Committee currently meet once every three weeks and minutes of these meetings are publicly available. The minutes give an overview of all topics discussed and decisions made but do not detail any decision making processes. The Committee is supported by a staff to carry out the detailed analytical work.[28]

Details of all CCC recommendations are presented to government and made available to the public to ensure transparency and in this respect the CCC operates in a similar manner to the MPC. The procedures on decision making are very open although there is a provision for anonymity where freedom of discussion would otherwise be limited. Whether this intended transparency occurs in practice will only become apparent in due course. The government then uses the CCC's advice when it announces the carbon budgets in tandem with its annual fiscal budget. These carbon budgets detail exactly the amount of GHGs/carbon that can be emitted in the whole UK economy over a certain period. These are budgeted entirely on production-based methodology, and are detailed further below. The CCC must present an annual status report to parliament on how the government is progressing towards the carbon budgets, to which the government must also respond.

[28] The CCC is jointly funded by the UK and devolved administrations and has a secretariat of 25 staff.

The CCC was initially tasked with advising the government on the following areas:

(i) The 2050 UK target emissions level

The CCC provides a recommendation on the appropriate long-run emissions level for the UK. In reaching this recommended target, the CCC looks first at what global temperature stabilisation should be aimed for in 2100, estimating the effects of different temperature-increase scenarios. The stabilised global temperature suggested is $2C^0$ above 1900 levels. From this agreed temperature the CCC then identify the corresponding, globally stable level of emissions. This seems to build upon and update the work by Stern (2006). After this they set a global long-term target for 2050 from which they are then able to set a UK 2050 target as a proportion of this, taking into account burden-sharing methodologies, international agreements and a technology vision for the UK. This process encompasses the principle of 'common but differentiated responsibility' and convergence of emissions per capita throughout the world.[29] The basis for these decisions is made public in order to give transparency to the process. All of this is a huge task in itself but is a necessary precursor to informing any UK level analysis.

The 2050 UK target set by the CCC in December 2008 is an 80% reduction below 1990 emissions levels. This is an increase from the original 60% target (Stern, 2006) and was adopted in response to updated scientific evidence on the potential impacts of climate change, and also the realisation that recent concentrations of GHGs have proved to be higher than previously thought.

(ii) Carbon budgets for the periods 2008-12, 2013-17, 2018-22

The CCC also recommend to government medium term reductions in the form of 5-year carbon budgets which assist in achieving credibility, compared to the alternative of having a single, long-term target for 2050. There is a legally binding requirement that the 2018-22 GHG budget must be 26% below the 1990 emissions level. Points (iii) and (vi) below will also be considered as part of these budgets and the CCC will set out a trajectory to 2020 based on many considerations, including an estimated carbon price. These 5 year budgets should be setting the emissions path towards achieving the 2050 target. In their first report, the CCC has proposed an Interim Budget of a 34% reduction in emissions by 2020 compared to 1990 levels, which

[29] This seems to imply a convergence in consumption per capita throughout the world in the long-run. Stern (2009) states that average emissions of two tonnes CO2 per capita worldwide would be required eventually to make the required reductions.

should apply if no global deal is reached. They have stated however, that if a global deal is reached, a more stringent Intended Budget, of a 42% reduction should apply to the UK by 2020, as more reductions could be achieved through tightening of the EU ETS allocation and global market mechanisms such as emissions trading and CDM projects (CCC, 2008b).[30]

(iii) Within these budgets the relative contribution of traded versus non-traded sectors needs to be identified

Currently around 50% of the UK's carbon emissions are covered by the EU ETS. The CCC must consider the relative split in the budgets between those sectors covered by emissions trading and those not covered under any trading scheme, which are likely to require different policy solutions. [31] This is of particular importance to achieving reductions at minimum cost and a major issue is whether domestically produced carbon which is part of the EU ETS should be included in the CCC budgets. This will be discussed further in sections 4 and 5.

(iv) The inclusion of international shipping and aviation

The CCC analyse how important the inclusion of shipping and aviation is in lowering UK emissions, how much these sectors should contribute, as well as the practicality, methodology and timing of their inclusion. It was decided that these should be considered but not formally as part of first budgets. The CCC produced an Aviation report (CCC, 2009b) specifically discussing the main issues in that sector. The Scottish government is also currently considering how formally to incorporate these sectors into its targets[32]. Obviously this will be an area of some contention but its inclusion is imperative at some stage given the increasing demand for air travel and shipping due to globalisation and the global nature of climate change. Aviation will be included in the EU ETS from 2012 and sector-specific international agreements may be necessary for these given their unique nature and international scale.

(v) Whether to include all GHGs in the above budgets

Given that Kyoto commitments relate to GHGs as a whole, but the EU ETS only covers CO_2, there seems to be a need to decide on the precise definition of what emissions are included within the CCC budgets. The CCC initial report decided that

[30] The Interim budget is based upon a 20% EU reduction with no international agreement and the Intended budget is based upon a 30% EU reduction with an international agreement in place.
[31] The sectors covered by the EU ETS are generally referred to as the 'traded sector'. This is not to be confused with the distinction between traded and non-traded goods, which depends simply on whether the good in question is traded across national (or regional) boundaries.
[32] See Climate Change Act Scotland (2009)

all GHGs should be part of the budgets and targets because: all GHGs contribute to climate change (some more so than others e.g. methane has a global warming potential 21 times that of CO_2); UK Kyoto commitments are listed in terms of GHGs, and the inclusion of more gases allows greater flexibility in achieving targets. This, however, raises fairly complex issues concerning the tracking of all GHGs and the likely impact of some policies, like the EU ETS, which only target certain GHGs. The CCC sees potential for non-CO_2 abatement opportunities in agriculture and waste, as well as possibilities in forestry. They stress that more work needs to be done before putting a policy framework in place for agriculture.

(vi) Extent of reliance on credits used to achieve targets/budgets

Recommendations must be given on whether credits from Kyoto flexible mechanisms such as Certified Emissions Reductions (CERs) from the Clean Development Mechanism (CDM) should be purchased in order to achieve the domestic emission reduction targets by cutting emissions in developing countries with lower abatement costs. These can be purchased directly through projects or through the EU ETS and Kyoto credits will tend to be cheaper than European Allowance Units (EAUs). This offers a more cost effective alternative to cutting domestic emissions, but seems at odds with the notion that countries should take full responsibility for their own actions, and that the UK should take a lead by providing an example for others to follow.[33]

However the CCC must also take the following issues into account when making any carbon budget recommendations:

- *Competitiveness Issues*

The CCC must consider which industries are potentially at risk, what policy regimes might affect marginal costs, the scale of possible effects and how these can be combated.

- *Fuel Poverty*

The CCC models the impact of carbon budgets on different households with particular concern for lower income households and look at what present and possible policies may be appropriate to reduce the negative effects that carbon budgets may have.

- *Fiscal resources*

[33] The CCC suggested that no credits should be purchased under the Interim budget and the government has agreed to follow this recommendation.

This should take auctioning of allowances into account i.e. double dividend, which can be used for revenue recycling. Also there are fiscal implications for government expenditure of possibly purchasing Kyoto credits to meet targets. More generally they must also consider whether taxed activities will change in volume and whether alternative fiscal instruments are required to achieve goals.

- *Security of Supply*

This mostly concerns the risks attached to different energy forms and combinations as well as the capacity of the electricity grid and supply to meet energy demands. In particular the intermittent nature of renewables and their transmission to the network/grid is a concern as well as how international politics affects dependency on foreign energy imports. The benefits of a diverse portfolio of energy sources must be a consideration in this context (Awerbuch, 2000). Relying too heavily on one source of energy has limitations e.g. open to oil price shocks or exogenous political influence, and so risk can be minimised through appropriate diversification of available technologies.

- *Regional effects*

The CCC will disaggregate their budgets for separate parts of the UK and look at non-traded sectors for devolved authorities which have their own policy mechanisms. A coordination of policies would ideally be required here to achieve the most efficient outcome at a UK level and the CCC will offer guidance to regional administrations.

- *Ancillary environmental effects*

An example given by the CCC is of a long term shift to electric cars which will not only reduce emissions but will have an extra dividend of benefiting air quality (although this does depend on how the electricity is generated).

An adaptation advisory sub-committee on climate change (ASC) has also been created under the Climate Change Act, which is responsible for advising government on measures of adaptation necessary in the UK. Obviously the work on mitigation and adaptation are closely linked and the ASC will work closely with the CCC on many areas. The ASC has three main objectives (CCC Adaptation sub-committee, 2010). Firstly to oversee the development of the first Climate Change Risk Assessment (CCRA), a government report on the impacts which climate change may have in the UK, which must be produced before January 2012 and subsequently every five years. The ASC will provide advice for the CCRA throughout the period up until

six months before the report is due. Secondly, the ASC must 'assess the preparedness of the UK to meet climate change risks and opportunities' by monitoring government progress towards meeting the objectives of the CCRA. This will involve progress reports being submitted in a similar procedure to that of the CCC. Thirdly, it is given the broad ranging task of promoting effective adaptation by all society through working with stakeholders and encouraging discussion on what steps can be taken in adaptation.

4. WHICH MODEL BEST FITS THE CCC?

We think it productive to enquire which model best captures the CCC as an institution by comparing the CCC with each possible motive for its establishment that we outlined in Section 2. We start with an evaluation which assesses the CCC as a potential solution to the time inconsistency problem and move on to discuss the information provision, advisory and monitoring functions separately. We then consider specific issues concerning the setting of carbon budgets, extra considerations and policy interaction.

(4.1) Time Inconsistency and comparison with the Monetary Policy Committee

Helm *et al* (2004) proposed an institutional change to solve time inconsistency in carbon policy and gave three possible options for an energy institution: a) one with a delegated welfare function, b) a conservative-central-banker-type climate change agency and c) an MPC-type agency with control over a policy instrument.

It would be interesting to know if the CCC is maximising a welfare function and what the arguments and composition of such a function would be. Here the government would ask the CCC to maximise a specific welfare function. Given the many factors the CCC is required to take into account, a welfare function could presumably include all of these, with weightings that indicate the relative importance of different objectives. However, it seems clear that the CCC has not in fact been delegated a welfare function, and in any case it has no way of setting or controlling policies though it can influence them. While a welfare function could be used as the basis for the CCC recommendations there is no reference to this. Perhaps the CCC could be

viewed as strongly influencing or setting the government energy-welfare function through the carbon budgets, but if so, it is clearly implicit. Not revealing a welfare function where one actually guided the CCC's recommendations would certainly go against the principle of transparency on which the CCC clearly depends for creating credibility.

A more specific welfare function would apply if the CCC represented a body analogous to the 'conservative central banker' solution in monetary policy. This would involve delegating a welfare function to an institution which attaches a heavy weight to reducing emissions, perhaps by appointing members with a strong environmental background. Given the emphasis of the CCC on mitigating climate change, it seems likely that they weight emissions at least as much, and probably more, highly than the government. This suggestion is consistent with the CCC announcement that the 2050 target should be at least an 80% reduction from 1990 levels, which led the government to alter its previous 60% reduction target. However, this shift reflects a scientific judgement rather than environmental preference – CCC take a decision on a target temperature and the emissions reductions needed to achieve this. Then detailed advice on how the necessary emissions reduction can be achieved is provided. It therefore appears to be the science and not the committee members' preferences that mainly drive decisions in the CCC, at least in this instance. There are areas that do require members to make decisions based upon judgement and not science, such as deciding on a methodology to apply in choosing a reasonable UK share of worldwide emissions reductions.

The final possibility is the solution outlined by Helm *et al* (2004) in which an institution is given a policy instrument to achieve a single objective – akin to the solution favoured in monetary policy. In all likeliness it seems that the MPC has been the political and theoretical inspiration for the creation of the CCC given that it was seen as a tried and tested method for solving time inconsistency:

"In economic policy, everyone can see that independence for the Bank of England has worked.... We now need Gordon Brown to understand the need for a 'Bank of England moment' when it comes to climate change"[34]

This quote from David Cameron in 2007, although obviously not reflecting the views of the government of the time, illustrates that the general political motivation and momentum in parliament for an independent committee on climate change, seems to be strongly linked to the idea of time inconsistency and the analogy with the MPC.

There are similarities between the MPC and the CCC. Both have a strong, forward-looking remit which involves technical decisions made by expert members within a transparent process, or at least a process that is declared to become transparent in the case of CCC, through the use of publicly available minutes. Each of these institutions uses the current evidence at their disposal to formulate projections of future outcomes and attempts to influence future expectations. They are even similar in that both have to use their expertise to come to a decision on precise quantitative changes: the change in the base interest rate and the government carbon budget relative to a BAU comparison. Also both have flexibility incorporated in to their process; the CCC recommends carbon budgets to be met over a *five year period*, and the MPC is allowed to deviate 1% either side of its inflation target before sanctions are imposed. The independence of both bodies is strongly stressed as necessary to fulfil their remit and essential to tackle the problem they are addressing and therefore neither body is staffed by government employees. However, there are several major differences between the CCC and the MPC in terms of the problem they are solving and also in their operation.

4.1.1) Time Scale

The time scale of the problems being tackled in monetary and carbon policy differ significantly. Any analysis of the economy over time is heavily dependent upon what theory of expectations is adopted. Both monetary and carbon policy are trying to manage expectations but may use different discount rates in their analysis and approaches to modelling. With monetary policy, expectations typically relate to a

[34] Cameron, D., (2007), "We will keep up the pressure on climate change", Green Economy Conference [Speech], 12/03/2007

shorter time frame, and influence both short and long-term investments. It is said that changes in interest rates will generally take two years to have an effect on inflation. However, the time inconsistency problem faced in the context of carbon policy relates to a much longer time scale, which includes considerations, at least in principle, of the welfare of generations quite some considerable time in the future. Some climate change analysis has tended to use discount rates which are lower than most prevailing interest rates or social discount rates used in public-sector cost benefit analyses.[35] Most private sector decisions will relate to expectations over the life-cycle of investments. With renewables this may be considerably longer than most investments e.g. 20-30 years for a wind farm or even longer for a nuclear power plant. The long-lived nature of such assets means that decisions on new energy investment tend to only occur when the assets require to be replaced or new supply is needed. The government in this instance is trying to influence expectations of carbon emissions decades into the future. Feedback is also a lot faster for the MPC than the CCC as it can observe its influence in a relatively short time frame and can do so through a very clear indicator, namely the returns on inflation-indexed bonds.

In this instance carbon policy perhaps has more in common with the oil industry which also requires a certain amount of credibility for investment to take place. The oil industry it is open to similar time inconsistency with investments undertaken over a similar time frame and is therefore similarly taxed and regulated by government. Oil too is potentially exposed to large price variations over time and so future markets have developed. Companies seem happy to make risky investments in oil exploration and extraction, but not so with renewables to the same extent. However, a difference is that the many renewable technologies are dependent upon government support in order currently to make them competitive whereas the oil sector has been operating for a long time. Given the central role oil has played in the worldwide economy over the previous century, the heavy dependence of our infrastructure upon it means there is therefore an inelastic demand for oil. If infrastructure changes this may change in the not too distant future if renewable energy sources replace oil in countries energy mix.

[35] Stern (2006) used a discount rate of around 1.4%.

The time scale of decision making for each body also differs. The MPC updates its decisions using a variety of evidence on new data and estimated future trends on a monthly basis, as this is what is necessary for monetary policy. The CCC reports annually to parliament and also produces reports on specific areas on an ad-hoc basis. Each report the CCC makes entails many months of in-depth preparation. This lengthy process is due to the technical differences involved, which we now consider.

4.1.2) Technical differences

A framework for comparative policy analysis involves looking at the instrument-target-goal relationship for any policy area. An instrument is used to achieve a desired goal; however normally this goal is difficult to accurately measure and therefore a target is generally used as an approximation or indicator for the final policy goal.

Both the CCC and MPC have to agree on a decision of a specific quantitative change. For the CCC this is a carbon budget, i.e. a change in the desired level of emissions. For the MPC the decision is a change in the level of the interest rate. The CCC's decision relates to a change in a policy *target,* and the MPC's relates to a change in a policy *instrument*. However, the decisions made by the bodies are reached through dramatically different processes.

The relationship between variables is significantly more complex with climate change than is the case with monetary policy. There is substantial empirical evidence relating the instrument-target-goal relationship in monetary policy. There is a relationship between the instrument (interest rate) and target (inflation) that has been long established, and although not certain in timing and degree, a clear chain of causality exists, at least out-with financial crises. There is also then a link between the target and the ultimate goal, which in this case is price stability. As stated above it generally takes a year or two for a monetary change to manifest itself in the economy. There is considerably less certainty in the transmission mechanisms involved in how emissions reduction targets directly affect climate change (goal). With climate policy, given the life of CO_2 in the atmosphere, a change in emissions may take a century to affect temperature – so the effect of making emissions reductions now cannot be witnessed until much later. There is therefore much greater uncertainty over how the climate system works and over the transmission mechanisms that relate policy instruments to

policy goals, than is the case with the MPC. Also the policy goal is global, and therefore it is difficult to gauge whether the national targets are actually affecting this goal. Though, as recent events have demonstrated, our understanding of these linkages, even in the case of monetary policy, is perhaps not as good as had been believed.

One problem with setting an emissions target is that it is based, in part, on ambiguous equity considerations: these inform the decision on an "appropriate" UK share of total world emissions. The CCC currently uses a combination of burden-sharing methodologies to decide upon an appropriate UK share of global reductions and costs.[36] Here there is evidently an element of moral decision making which does not appear in monetary policy. Almost everyone benefits from stable inflation, and the government only benefit (from increasing inflation) in the short term but with a risk of loosing credibility. However, with climate change the groups which are affected are more heterogeneous, and some may be affected a lot more than others. There are inevitably some "losers" from climate change mitigation e.g. those dependent upon fossil-fuel-intensive production processes, and this can make efforts politically difficult. Given the large uncertainties and risk that exist in climate change, it seems that carbon policy should be influenced by the notion of the 'precautionary principle'[37], and therefore should be a more conservative body than the MPC, as monetary policy does not entail the same degree of uncertainty, nor the possibility of such extreme, irreversible outcomes. [38]

One specific difference between monetary and carbon policy is that of symmetry of the targets. In monetary policy the MPC has a symmetrical inflation target of 2% where the MPC must send a letter to the Chancellor of the Exchequer if the inflation rate deviates one percent either side of the target. However, a deviation either side of that is treated the same – above is not better than below, and vice-versa e.g. a 1%

[36] These include "per capita convergence", "common but differentiated convergence", "Multistage", "Triptych" and "Intensity". For details see CCC (2008b) chp. 1

[37] The precautionary principle is a legal argument often used in the making of policy. An interpretation is expressed in the UNFCCC Rio Declaration Principle 15 and states that "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

[38] Although, of course, there are numerous examples of disastrous monetary policy being adopted.

inflation rate is as incorrect as a 3% inflation rate. This allows for fluctuations either side of the 2% target. Climate change targets appear to be asymmetrical. It seems generally agreed that over-achieving is considerably better than under-achieving and success will often be judged upon the over-meeting of carbon budgets. In this sense it seems that climate change targets are asymmetrical. This may be related to the precautionary principle and shows an important difference between policies directed at inflation and those focussed on climate change. However, over-achieving may not, in fact, always be desirable as it may be at the expense of other policy goals such as economic growth e.g. the extra reduction in emissions may reflect a cut in output. This trade-off between growth and the environment considerably complicates the conduct of energy policy. Perhaps the "extra considerations" that CCC is charged to take into account is an acknowledgement of these difficulties in reconciling policies that may be at odds. The trade-off between these goals is discussed further in the section on *Extra Considerations.*

4.1.3) Compositional and Institutional setup

There are differences in the composition and rules relating to both bodies. The MPC has strict rules on voting for decision making, with a majority of the nine members required and each member has one vote. The governor has the last and therefore deciding vote. The CCC however does not seem to be as rigid in its approach as there is no voting process. There is no indication as to how each CCC member's views are weighted throughout the process of reaching their carbon budget recommendations. It appears to be more of a team decision-making process for the CCC with informed moral judgements made along the way.

Unlike the case of monetary policy, the CCC is not the only body involved in carbon policy. There are institutions that continue to operate after its creation, such as the Carbon Trust, the Energy Saving Trust and energy-policy-related institutions like the regulatory body Ofgem. Issues arise in certain cases due to the unspecified or overlapping remits of institutions, as agencies may be too narrow in scope to make sure all necessary considerations are covered by at least one body i.e. some important policy consideration may be missed. Alternatively, various institutions may be too broad in scope, possibly resulting in inefficiencies where two bodies have overlapping functions. During the 2008 recession it was at times unclear as to whether the MPC or

the Financial Services Authority (FSA) was responsible for tasks. With energy institutions there seems to be much more overlap with many institutions doubling up on similar goals and needing to take other energy goals into consideration. This could possibly be beneficial to policy if it provides highlights differing views and competing ideas but this will only be positive if the overlap is intentional and all parties are aware of it. There has to be more clarification given to bodies, especially energy institutions, on what their exact remit is and this must be clearly expressed from the outset to them and the public.[39]

The CCC appears to have too many ancillary considerations, if they are genuinely to be taken into account, and for the CCC to be wholly effective in achieving its primary objective: tackling climate change. The creation of the CCC was an opportunity to tidy-up the energy institutional setup, by creating an institution specifically directly to tackle emissions reductions, and perhaps also security of supply, which is dealt with along with the other extra considerations we discuss further below. Yet the numerous considerations seem only to add to the existing complexity and potential confusion. On energy policy in general Helm says:

"The objectives –and the underlying market failures-are multiple, and need multiple policies simultaneously applied to address them. The more objectives, the greater the number of instruments required and, crucially, there is a need to define the trade-offs between them."[40]

4.1.4) Policy Instruments

The CCC has no obvious instrument with which to achieve goals: it has not been delegated instrument-independence the way the MPC has. In fact it is almost the exact inverse of the MPC in so far as it appears to be *setting* targets rather than being charged with *meeting* them. This seems strange given the likely importance of the MPC as a basis of a model for the CCC. However it may be that the government is viewing the setting of targets virtually as "instruments" in themselves or at least as a surrogate for a non-specified instrument. In practice the CCC's five year budgets could be viewed as the instruments used to influence short/medium run emissions

[39] For a more general discussion about the role of NDPBs in government and how changes could be made to improve their efficiency see Institute for Government (2010)
[40] Helm (2007a) p.21

expectations, and the fact that the budgets are legally binding should add credibility, therefore significantly influencing, if not setting, public emission expectations. The credibility of targets can be backed up by emphasising the negative outcome of not meeting the budgets. However, we feel that this view of target-setting as an instrument is unlikely ultimately to hold much weight. Firstly, CCC recommendations are not themselves legally binding. Secondly, if agreed budgets are not in fact met in practice and there is no instrument other than the budgets themselves, then the CCC has no means of ensuring that targets are met. Therefore the analogy with the MPC, while appearing in some very general sense to have underlain the creation of the CCC, does not in fact hold in practice. We return to the concept of the CCC actually being delegated an instrument, such as a carbon tax, later on when discussing policy interaction. However, if multiple equilibria exist, with the government deciding between possible high and low temperatures as an equilibrium, then the announcement of targets may help achieve a stable outcome as the private sector will adjust their expectations and make decisions appropriately. Even when the MPC does not meet targets the credibility of the system still typically holds due to the reputation of the committee and also the transparency involved. The MPC were always able clearly to explain any deviations from inflation targets and put them into context in terms of the long-run path of the economy.

(4.2) 'Rolling Stern *plus*' model

In practice, it seems to us that the role of the CCC is in fact best viewed as an advisory 'Rolling Stern' model, which incorporates an additional monitoring function. Rather than being a delivery body of the government, the CCC appears to inform government policy and the delivery of the policy is achieved by government itself and through independent bodies such as the Carbon Trust. Scientific and economic advice on climate change has been provided in the recent past. In 2006 Sir Nicholas Stern, who was at the time head of the Government Economic Service, and his team, provided the British government with the most comprehensive review on the economics of climate change ever undertaken (Stern, 2006). The review was hotly debated and was generally heralded as a world-leading insight into climate change policy, discussing issues at both a national and international level. This report combined principles of science, economics and moral philosophy in order to arrive at a conclusion as to the extent of reductions needed. At a more general level the Stern

review can be seen as an attempt to form a consensus on a target level for emissions reductions and therefore act as a reference point for both UK and international energy policy.

Since the Stern review it has become clear that there is a need for this work to be continuously updated to provide more in-depth, timely advice on climate change to all interested parties. Due to the high levels of uncertainty involved with climate change our understanding of the science is constantly evolving. The changes in the science then inform developments in the economics of climate change, and government must be kept abreast of these changes when making policy. Given the complexity of the information, which may be manipulated by interest groups, it seems appropriate to have an independent advisory body that can provide advice on a continuing basis to the government on the necessary changes that need to be made.

This sort of 'Rolling Stern' body is the "model" of delegation that the CCC appears to be closest to. More precisely this body would advise on the necessary emissions reductions required to avoid some agreed 'tipping point' temperature i.e. a catastrophic temperature which should be avoided, or perhaps a 'tipping range' would be appropriate given the level of uncertainty in probabilities, as such a stabilisation of between 450-550ppm in 2050 has been recommended. We do not know exactly what the costs of any given temperature rise will be, especially with uncertain irreversible events like the melting of ice caps or permafrost.
"The essential task of the Committee can be summed up as providing advice on how fast the UK can and should progress towards a low-carbon economy and how it achieves that progress."[41]

The CCC can be seen as a "Rolling Stern *plus*" model because as well as work comparable to that undertaken by Stern, it also incorporates the monitoring role that was suggested by Helm *et al* (2003) as being the most likely UK outcome of a new institution for solution of the time inconsistency problem of carbon policy. These two roles, as an advisory body and also a monitoring body, make up the real remit of the

[41] CCC (2008b), foreword p5

CCC from the possibilities for delegation discussed in Section 2. This may still provide a degree of credibility for carbon policy to investors.

The composition of the body, in terms of its members, appears to be well judged in that it is mainly comprised of individuals from a strong academic background whose unbiased experience make them well placed to advise government on the many issues involved in climate change. The mix of well respected individuals should give the CCC the expertise, and hence credibility, it requires to fulfil its duties.

The incorporation of an adaptation sub-committee should also be welcomed as both mitigation and adaptation need to be considered in light of the science which suggests that some adaptation will be required in the UK. Therefore expert advice is needed to inform the government's strategy on adaptation. Changes in UK temperatures will affect many individuals and industries through increased droughts, flooding and extreme weather. Stern (2006) discusses the economics of adaptation, and explicitly incorporates modelling of it in the analysis. This sub-committee of the CCC can build on that to provide a detailed analysis of the relevant UK issues and could therefore be considered an additional "plus" in the "Rolling Stern plus" model.

The other possible reason for delegation outlined in Section 2 was "Information provision". The CCC does not seem to be fulfilling such a role. It is providing advice for the government but not directly to the population at large; public information is being disseminated by the government through various other channels. The CCC does provide yearly reports in parliament that must be responded to by the government. This information they are providing is public but it is not directed at the public. There may, however, be a need for information provision to the public from a reliable and trusted source. In the lead up to Copenhagen in 2009 and beyond the science on climate change came under severe attack, especially after the so-called "Climategate" affair where numerous e-mails were leaked from researchers at the University of East Anglia pertaining to inaccuracies in data used in an IPCC report and also the holding back of data. The lack of transparency here was severely criticised by independent reviews.[42] Although the debacle was blown out of all proportion, it is an indication

[42] For one such independent review commissioned by the University of East Anglia see Russell (2010)

that public trust in the credibility of climate change information is very fragile and must be treated with due care. Perhaps an existing institution such as the Carbon Trust or Energy Saving Trust could take on this role as currently these bodies operate as separate entities to government, such delegation may be beneficial in preventing any potential data manipulation. However, an 'information providing' body would be required to work more closely with the CCC and government to ensure cohesion of information distributed and policy.

In both its advisory and monitoring functions the CCC is a Non-Departmental Public Body and therefore must operate within any guidelines on NDPBs issued by the government. More generally there has recently been some contention over the role that such bodies play within the political sphere and to what extent they are effective and truly independent. The independence of the Advisory Council on the Misuse of Drugs was questioned in November 2009 after the Home Secretary Alan Johnson sacked the Council's leader Professor Nutt for crossing a perceived line into politics. Professor Nutt had publicly stated in a lecture that the government's decision to reclassify cannabis went against scientific evidence and was made purely for political purposes. The Home secretary felt that Professor Nutt had openly criticised government policy and duly dismissed him after "losing confidence" in his advice. A number of other council members resigned in protest and this incident has sparked much debate over how independent these advisory bodies can actually be and how government interprets scientific advice. The government responded quickly by issuing guidelines pertaining to how advisory bodies should function. Yet the recent events with the Drugs advisory council have perhaps changed this perception of how NDPBs are viewed. Government may choose not to follow the CCC's advice but in such circumstances it runs the risk of severely damaging the reputation of the body it created, if no compelling reason can be given for going against the advice. The CCC however seems to be billed as more than just a NDPB, Instead it appears to be a body who would strongly influence policy and whose independence would be complete, much like that of the MPC. Both the Bank of England and the CCC are heavily enshrined in domestic legislation and therefore appear to carry more weight than regular NDPBs which can often be setup in an ad hoc manner.

The next section evaluates many of the features of the CCC. In particular, issues surrounding the setting and implementation of carbon budgets, its extra considerations, monitoring functions and the interaction of the CCC budgets with other instruments and spatial levels.

5. Evaluation of the CCC

(5.1) Setting carbon budgets

There are still issues and questions surrounding the advisory nature of the CCC, mostly related to the setting of carbon budgets and whether the government always accepts the CCC's advice. In practice, the successful meeting of budgets is critically dependent on many external factors that are exogenous to the CCC (and to the government) such as the price of oil and the price of carbon within the EU ETS. The CCC has obviously incorporated this into its modelling but the extent to which these factors affect budgets may well make it difficult to meet them. The EU ETS carbon price, which covers roughly 50% of UK emissions, has fluctuated substantially since its inception in 2005 (This is discussed further regarding spatial scale). Also the condition of the world and UK economies will impact significantly upon whether short and medium-run budgets are actually met, and budgets may have to be adjusted for fluctuating economic circumstances. Economic growth and emissions are intrinsically linked, and there is most likely a trade-off between them. For example, at an international level the UK has found it comparatively easy to meet its Kyoto targets in part because of the decline in the UK coal and steel industries since 1990 and also the change in the price of gas making it relatively cheaper than coal. This then lead to a greater dependency on energy imports in the UK while domestic production has decreased. Meeting targets has been more likely down to circumstance rather than effective policy. There is, of course, no guarantee that events will act fortuitously to ensure the satisfaction of carbon budgets.

Also in the same way that economic turbulence can affect monetary policy, it can also raise similar issues in carbon policy. There were calls for reducing targets because of the 2008 recession as firms were under enough pressure without having extra responsibility. Thankfully there have been encouraging signs that the CCC is looking

long-term, as Lord Turner has stated that budgets will not be revised in light of the current recession. However it must be noted that the budgets should be targeting the economy operating at 'full capacity' i.e. budgets should be explicitly predicated upon the long-term growth rate. In a recession it will actually be easier to meet emissions targets, therefore possible upward revisions may be necessary i.e. strengthening of earlier carbon budgets to achieve the longer term targets. This depends upon how budgets are expressed because due to the time GHGs stay in the atmosphere, it is important that targets are concerned with cumulative stocks of emissions rather than flows. As the change in temperature is a direct function of the stock of carbon (or equivalent) then any targets should themselves be in stock terms. However the downturn in economic activity will make it harder to fund future projects given reduced investment and higher government deficits. Shocks to the world economy may well severely affect projected growth rates and this may drastically alter underlying assumptions on which the budgets are based. Therefore the CCC must make informed judgements as to whether events are cyclical, and so should not alter their analysis, or whether an event shifts the path of the economy and therefore carbon budgets must be modified appropriately. All in all, there are multiple factors which may require the carbon budgets to be revised, and these factors may occur concurrently and in varying directions. The CCC is well aware of theses issues and has very detailed analysis in place. Generally it is worth noting the extent to which key determinants of actual emissions are outside the direct control of the CCC.

It is also not clear what the government budgets being 'legally binding' really means in practice. It certainly conveys the impression of conviction, but to what extent does it genuinely boost credibility? If there is no actual legal challenge to the government not complying with the carbon budgets, then does having these budgets enshrined in legislation actually provide any additional credibility at all? Judicial review is a legal challenge to decisions of government bodies which have exceeded their own powers. If the targets are legally binding, this opens the possibility that the government could be legally challenged in court over non-compliance with meeting targets or taking decisions that undermine the achievement of targets. There are varying opinions on whether this is a real possibility as the government can change the targets themselves later anyway, but the extent to which this is done in practice will affect the credibility of the whole process and may partially undermine the CCC. However, in practice it is

unlikely that any sort of judicial review of decisions on climate policy would be successful due to the strict application requirements and the political consequences of allowing the possibility of legal challenges. There has been mention of legal action taken by Green groups on specific government decisions that may have significant implications on the ability to meet the carbon budgets, for example, the extension of Heathrow airport, new nuclear power plants and a potential new Forth Road Bridge. So far the only precedent has been a case regarding the extension of Heathrow airport where the judge ruled that the government must reconsider their decision to allow expansion as the full information was not known at time of the decision, and the CCC report was heavily cited throughout (Bowcott, 2010). Therefore it seems possible that the courts may legally oblige government to take decisions again but not actually decree a particular decision illegal and require government to justify their decision in light of new evidence.

The frequency of budget setting is a trade-off between, on the one hand, trying to provide certainty for investors, which would be brought about by annual year-on-year targets (assuming there is confidence that they will be met) i.e. one year carbon budgets detailing in advance how much can be emitted each year for a given period e.g. five years. On the other hand, the benefits of flexibility and lower reporting burden of less frequent budgets. An issue with setting 5-year budgets is that the reduction is an average across that time period. However, as mentioned previously, the stock of carbon in the atmosphere is more important than the flow. Perhaps budgets should be set more frequently. Although, the setting of annual targets does not necessarily imply certainty; increased frequency may make it more difficult to consistently achieve targets. For example, if a nuclear station had to shut one year unexpectedly, then it would be necessary to rely on coal and gas to make up the difference and thus emissions would substantially increase for that single year. The Scottish Climate Change Act has established the requirement of such yearly carbon budgets in Scotland. It will be interesting to see how these are set and met in comparison to the UK budgets, especially given Scotland's current dependence on a small number of large generators. The CCC's report to the Scottish government (CCC, 2010) has expressed concern with the lack of flexibility in the Scottish annual targets and suggests measures could be considered to increase flexibility, although it

is not within their remit actually to recommend doing so. (We return to discuss the appropriate spatial scale for further analysis comparing Scottish and UK legislation).

The CCC has decided to include all GHGs in its budgets. Although CO_2 makes up most GHGs, many of the others are more potent and dangerous for the environment. The CCC has called for the government to set out an agricultural climate change policy. They see this is as being slightly problematic due to the difficulty in collecting data in such a sparse sector as agriculture where measuring emissions may be onerous and costly. Including all GHGs will allow greater flexibility in reaching targets and is consistent with the UK's Kyoto targets although it will increase monitoring cost for government and the complexity of modelling for the CCC. However, CO_2 emissions have actually risen over the last ten years while non-CO_2 gases have dropped due to changes in industrial processes and agriculture, in particular methane emissions have significantly fallen from waste in landfill (CCC, 2008b). Therefore if trends continue this way, the reduction efforts will have to still be concentrated on curbing CO_2 emissions from growing too much, as in practice they contribute by far the most to causing climate change, while other GHGs may continue to decline.[43]

International aviation and shipping have not yet been included in the budgets although these transport sectors are of vital importance to the debate as they are an ever growing contributor to UK and worldwide GHG emissions. Deciding the method to be used to include these will be a near impossible task if they are to be done precisely and their inclusion could have large competitiveness impacts. The issue is mainly one of who takes responsibility for emissions. The CCC feels more effort and research is needed on this topic before these sectors can be accurately incorporated into the carbon budgets. The UK government has stated that its target is to allow aviation emissions in 2050 to be no higher than current levels. The CCC then produced an Aviation report in December 2009 that analysed projections in air travel and reached the conclusion that demand growth of 60% would be possible to achieve this given efficiency improvements and changes in fuel used and demand through appropriate policies (CCC, 2009b). This was against a likely business-as-usual scenario of a 200%

[43] Also the comparison of including only CO_2 versus including all GHGs may have different impacts for specific regions and sectors which may heavily use other GHGs e.g. agriculture; therefore differing impacts are worth discussing and perhaps analysing within a computable general equilibrium framework.

increase. The CCC state that global aviation emissions must be capped through an international sectoral agreement or by incorporating aviation into other targets and markets e.g. Air travel will be included as part of the EU ETS from 1st January 2012. How these emissions from either aviation or shipping are incorporated into budgets is difficult to decide upon. Emissions take place during travel between countries, so where should It would be possible to incorporate emissions from air travel and shipping on a consumption basis but this may be incredibly difficult to implement in practice. However, in practice introducing some rule of thumb is of course feasible e.g. emissions are split equally between origin and destination countries, and this is much better than simply ignoring such emissions.

More generally there is an issue in the UK regarding the use of production-based targets for domestic emissions reductions, which is also the methodology used by the UNFCCC. Currently the norm is for countries to account for their emissions based upon how much they produce within the country by summing the emissions from all domestic sources of production. However, this method completely disregards trade flows. If domestic production of energy-intensive goods moves elsewhere and these goods are then imported, the reduction in domestic emissions may make no contribution at all to combating global warming. Under a production measure such "carbon leakage" would give the impression that conditions have improved domestically, even if global warming is in fact unaffected. If UK domestic emissions from production decreases but is completely offset or perhaps even more than offset, by emissions leakage to other countries, since they may use even dirtier technologies, then this totally neglects the global nature of the problem being tackled. There is no point in the UK achieving an 80% reduction by 2050 if it does so entirely through displaced production but continued, or even increased, consumption levels. Also, given that the UK alone has a very minimal impact on climate change, then the argument for setting emissions reductions targets must be a mostly moral one. If this is the case then there is a strong argument for employing consumption-based accounting measures, to confirm that the UK's actions on climate change are indeed making a positive contribution and not merely appearing to.

Helm et al (2007) find that on a production basis there has been a 15% reduction in GHG emissions since 1990 but on a consumption basis over the same period,

emissions have risen by 19% and there has been a divergence between production and consumption accounts over time.[44] This shows a very different picture of emissions to the one being portrayed by government, where UK emissions are supposedly decreasing using a production-based method. The CCC would be more effective as a climate change body if it simultaneously discussed the UK's emissions from a consumption perspective although this omission may be because it is not explicitly part of its remit. Using consumption-based targets would, in principle at least, provide a more accurate reflection of emissions per capita. It would also likely be a stricter measure for developed nations although this depends upon the balance of trade (Helm et al, 2007). There is a trade-off to some extent because although consumption-based approaches may be more accurate, they are also more difficult to measure because of trade flows. Still, although measurement of consumption impacts is a more complex task than any production based analysis, it is not impossible and should be considered in parallel and steps should be taken to produce a range of measurements on UK emissions which would allow the CCC to monitor the movements of consumption and production indicators over time.[45] Stern (2009) argues that some worldwide convergence of consumption is needed if emissions are to be stabilised at the required levels. The CCC also has this view in its burden sharing methodologies. It therefore seems a significant limitation that the CCC, and more importantly any global agreement, neglects a consumption-based analysis of emissions. The CCC has an opportunity to establish that a consumption route is necessary in the long-run and that the UK can lead the way in establishing this path worldwide.

Personal carbon trading is a potential option highlighted by the CCC but needs further research and will likely be difficult to implement as it would entail high transaction costs. The CCC should look to begin establishing emissions accounting based upon consumption and how best to collect the necessary data, highlighting the difficulties involved and incorporating this into its monitoring function.[46] Getting detailed data on emissions intensity of all products imported and exported would be an enormous

[44] Although their calculations were only a crude approximation and therefore should not be taken as definitive. A far more detailed analysis is required

[45] For discussion of consumption- accounting methods see Davis and Calderia (2010) and also on environmental impact of consumption see Weidmann et al (2007). For comparison of producer vs. consumer responsibility see Munksgaard and Pedersen (1999).

[46] See Turner et al – parts 1 and 2 (2007a, b) for an overview of Input-Output attempts at consumption trade flows and McGregor et al (2008) for an attempt at Scottish vs. UK CO2 trade flows

task and would require worldwide cooperation and coordination. Therefore, these issues should be taken into consideration by government in formulating international policy. However short-cut methods do exist and should be used, at the very least to check for major divergence in production and consumption measurements over time. Helm (2009) suggests that a carbon tax should be employed which can also function as a border tax. It would tax the carbon/energy intensity of goods and would start off on goods which can be measured and become more inclusive over time. This would also create a price floor for carbon. Although the Project Discovery report by Ofgem highlights that this may prove difficult to implement as any national emissions tax will have to adhere to EU rules already in place (Ofgem, 2010). We return later to the possibility that the CCC could control such a tax as a policy instrument.

China seems to be adopting an alternative measurement of emissions by using carbon intensity of GDP as its reduction target. This is still a production based target and is therefore completely dependent upon growth of their economy. However a reduction in CO_2 intensity is quite consistent in a rapidly growing economy with an increase in CO_2 output. Having a production-based accounting method is however likelier to be tougher for China than a consumption-based method given that much of its emissions are currently for energy intensive exports to developed nations, although this may change over time as their standard of living and consumption rises.

(5.2) Extra Considerations

If possible, it is potentially important to distinguish between the considerations that genuinely impact upon the CCC decisions and those that are part of the more formal requirements, but are likely to impact less in practice. Only time and evolution of the CCC is likely to establish which considerations are truly important and at the forefront of the decision making process in their reports. Even here it may be that the CCC's priorities may vary with conditions, so it may prove impossible to reveal its preferences through deduction from evidence of its actions. Hopefully, its transparency should solve this problem. Should the CCC merely report on the possible impacts to these areas of concern but refrain from actually adjusting their recommendations based on possible impacts? Obviously the CCC has to be mindful of constraints but it cannot be expected to put an equal weighting on all concerns. As

mentioned earlier these extra considerations may represent an attempt to encourage CCC to recognise the linkages and interaction between various policy goals.

Competitiveness issues

This relates to both competitiveness issues within the UK and to competitiveness of the UK vs. rest of the world. Implications of carbon budgets may well affect the competiveness of certain sectors and so the CCC must be aware of what likely impacts may occur. Should the CCC only be commenting on the likely influence of its budget recommendations upon competitiveness of UK industries but not adjusting budgets downwards if negative effects are expected to be extensive? Perhaps though, at an international level, there is a bigger role for considering policies to maintain UK industry competitiveness. Overall the CCC sees no long-term competitiveness effects of carbon budgets, and the short term disadvantages only seriously affects a few industries which can be protected by appropriate policy levers.[47] Plus movement of industries to other countries may also cause carbon leakage. Any disadvantages will be offset in the longer term as the CCC does see potential for the UK having a competitive advantage in new industries such as wave and tidal energy which will compensate for any negative competitiveness effects.[48] The competitiveness of the energy sector within the UK is historically the main role of Ofgem which has established its main priority as protecting electricity consumers from exploitation by monopoly suppliers.[49] Any concerns on energy highlighted by the CCC will have to be communicated to and discussed with Ofgem to ensure consistency and cohesion within UK energy policy.

Fuel Poverty

The CCC cannot be expected to tackle fuel poverty, especially given that the natural way to tackle this is via the tax – transfer system which is out-with the CCC control. Obviously it can comment upon the impact carbon budgets are likely to have upon the fuel poor and then advise the government accordingly. Ofgem still have responsibility for ensuring consumers are paying a fair price for their energy, so again working with

[47] These few industries account for 1% of UK GDP and are regionally concentrated. Protection may come in the form of sectoral agreements or continuing free EU ETS allowances (CCC, 2008b: chapter 10)

[48] CCC take this from various sources including BERR (2008)

[49] Although recent outputs from Ofgem suggest a move towards broader concerns. See their recent Project Discovery (Ofgem, 2010)

them is a necessity. Government initiatives are often needed to help the worst off and elderly, who are most vulnerable. Through its modelling (designed by the Buildings Research Establishment) the CCC believes that electricity and gas price increases implied by the satisfaction of carbon budgets will impact heavily by increasing the number of fuel poor households by 1.7 million in 2020 which would cost £500 million a year to compensate for this increase.[50] They suggest the possibility of social tariffs and/or income transfers as policy measures to combat the increases.

Economic Costs and Fiscal Resources

The CCC will analyse what the likely macroeconomic costs are of implementing carbon budgets through higher energy costs, energy efficiency improvements, lifestyle changes and competitiveness impacts. They conclude that meeting the 2020 targets will cost less than 1% of GDP. The CCC also analysed the possible fiscal impacts of carbon budgets and concluded that a combination of positive and negative effects would likely occur e.g. EU ETS auction revenues but reduced fuel duty revenues due to the electrification of most transport. Fiscal neutrality must be responsibly implemented to minimise distortions. When analysing the impact of tax, it is essential to do so with fiscal adjustments implemented in a neutral way. (Of course, policy need not operate in this manner i.e. might want net additional tax to reduce borrowing. However, this is straying into macroeconomic policy and away from energy policy.)

Security of supply

Helm et al (2003) suggested that there should be an energy agency whose primary functions are climate change and security of supply, but there is no indication that the CCC should consider security of supply above any of the other 'extra considerations'. In their report the CCC distinguish between 'technical' security of supply and 'geopolitical and economic' security of supply. The CCC considers that 'technical' security of supply i.e. ability to meet demand, will not be undermined by renewables provided that necessary back-up capacity is available. When considering 'geopolitical and economic' security of supply i.e. insulation from exogenous price shocks and political events, they believe increased penetration of low-carbon technologies to be

[50] This is based upon various assumptions regarding electricity prices, gas prices, real disposable income and many more. See CCC (2008b) chapter 12

beneficial but give no approximation as to the extent of this benefit. Portfolio theory suggests that the use of a range of renewables will be important in improving the diversity of energy sources and reducing risk.

Regional effects

The CCC can comment on possible regional effects of carbon budgets. For instance, it may be the case that Scotland becomes an exporter of renewable electricity given its renewable potential.[51] Also the Scottish Government currently has a "no nuclear" policy for electricity generating capacity in Scotland even though energy is a reserved matter. Will this have any impact on how carbon budgets can be met? More generally is it beneficial for the CCC to look at specific regions or is there a possibility of duplicate work with other administrations? Given that the Scottish government has passed its own Climate Change Bill, requiring the setting of annual carbon budgets and allowing for the possibility of setting up a Scottish Climate Change Committee, are there any areas of contention? (See Scottish Climate Change Bill) Any complete regional analysis will need a model of that region. Also at a local level Regional Development Agencies have responsibilities and targets for sustainable development. Therefore there is a whole set of issues relating to multi-level governance (this is discussed further below). The CCC initially highlights the steel industry in Wales as potentially being adversely affected by budgets.

Ancillary environmental effects

There are likely to be many additional environmental effects from emissions reductions that aren't directly related to climate change. This may be a positive double dividend e.g. the reduction of emissions may also reduce air pollution in cities, or a negative externality e.g. loss of habitats for certain species due to changes in technology.

The CCC has a lot to contemplate in analysing the extra considerations it has been tasked with commenting upon. Their findings must be taken aboard by government and updated as more information becomes available over time. Other institutions such

[51]Scotland is currently a net exporter of electricity, but over the coming years some plants will be decommissioned.

as Ofgem and the Carbon Trust must be made fully aware of many of the findings regarding competition and technological advances.

(5.3) Monitoring functions

It is too early to tell whether the monitoring role of the CCC will be effective but many essential components e.g. independence, are in place, hopefully to ensure that the credibility it aims to establish is realised. Without some monitoring body there would be little chance of credibility being established and this role is where the strength of the CCC may well lie. The CCC's first monitoring report to parliament in October 2009 (CCC, 2009a) has called for a step-change in climate change policy in order to achieve future targets. The first report has no official data yet for the first budget period, but using emissions data from 2003-2007 it has shown that emissions are only dropping at a rate of less than 1% per annum over this period. It has called for an increased policy effort to materialise a 'step-change' and raise reductions to between 2-3% a year. To achieve this it specifically suggests a new approach with regards to power generation, stating that the current combination of markets and instruments is not working and new policies as well as a review of existing ones will be required. It also suggests that the role of government in home energy efficiency needs to be stronger as well as introducing new incentives for renewable heat targets, take-up of electric vehicles and increased public transport use. This report has been interesting as it has highlighted that the CCC will not only be assessing progress but also be forward-looking in its monitoring role, checking for key indicators to show that budgets are on the required path to meet targets. There are indicators for the power sector, energy use in buildings and also transport. This is to be welcomed because it should give investors valuable insight into the credibility of government policies and whether budgets are on track to be met. The first progress report to parliament also highlights how the recession has affected budgets and what should be done in response to it. They highlight that prices in the EU ETS have dropped significantly which may affect incentives to invest in low-carbon technologies. The CCC therefore recommends that the government aims to outperform the first budget and highlights that the current EU ETS carbon price cannot be relied upon to achieve the necessary emissions reductions. It also states that any outperformance of budgets should not be banked in future periods. Again this is to be commended as it shows the CCC is seeking to take into consideration those factors that will impact upon the

carbon budgets while still focusing on longer-term targets. They seem to accept that although it is important to have flexibility in meeting targets, the cumulative emissions in the atmosphere are what essentially matters. Therefore any one-off external factor that influences emission levels should not be counted because it is the emissions path taken by the economy over time which will actually determine whether the cumulative target is achieved. We can't rely on recessions in helping us achieve our climate change goals.

Government must respond to the CCC yearly monitoring report in parliament. Only in a few years, once we have seen whether the government has truly taken on board the CCC's advice, will we be able to evaluate its significance. Also, the timing of the budgets - every five years - means that many current MPs may not hold office when the budget they set now is intended to be met. It is therefore imperative that the yearly monitoring reports of the CCC are detailed, commenting on whether or not they believe we are on the path to meeting targets and providing analysis of possible future obstacles or issues.

(5.4) Policy interaction and spatial scale

It is necessary to discuss how the CCC relates to different policy instruments and also spatial levels - be it a higher level e.g. EU and international climate change policy, or how it functions with UK-wide institutions, devolved administrations and local governments.

The policy interaction between the CCC's domestic carbon budgets and the EU ETS is a rather interesting area. As mentioned before, the EU ETS is an external factor than can influence the ability of government to meet the carbon budgets set by the CCC. In acknowledgement of this the CCC has created two possible carbon budgets: an "interim" budget and a tougher "intended" budget. Which one is adopted is dependent upon what cap is set in the EU ETS, which in turn is dependent upon whether there is a credible international agreement involving major polluters out-with the EU. If there is such an international agreement, then the EU will adopt a 30% reduction (as opposed to 20% if no agreement) by 2020 and this will then tighten the EU ETS allocation between 2012-2010 and increase the price of allowances. This is due to worries about competitiveness effects and to hopefully incentivise others to

follow the EU's example. Therefore the UK government will decide what budget to follow, intended or interim, dependent upon the EU's action and price estimations. Regardless, it is certain that the EU ETS will influence the domestic budget as around half of all the emissions in the UK are covered by the EU ETS. For those sectors not covered by the EU ETS e.g. transport, perhaps a CCC-controlled carbon tax or a separate trading scheme would be beneficial as a domestic policy instrument. Boemare et al (2003) highlight the issues between having national and European policies on emissions trading.

The accuracy of the CCC budget recommendations are actually heavily dependent upon the success of the EU ETS i.e. having a credible carbon price and a certain amount of trading is incorporated into the CCC models when deciding on the budgets. Much of the CCC analysis and modelling uses an estimated average carbon price of £40 per tonne of carbon in 2020 under a 30% EU target and central fossil fuel price assumptions, with sensitivity analysis where appropriate. Therefore the extent to which this price prevails in practice will affect the UK's ability to achieve carbon budgets and so the success of the EU ETS is critical to the success of the CCC. Recent price trends have shown some volatility and lower than expected prices.[52]

There have been issues with the EU ETS in terms of keeping a stable price, which has fluctuated in part due to over-allocation of grandfathered emissions allowances and the inability to bank and borrow allowances between periods. The EU ETS could be strengthened post-2012 with the introduction of more auctioning of allowances, which has been advocated by many academics (Grubb and Neuhoff, 2006) to minimise rent-seeking by covered companies, who currently benefit by making windfall profits from the grandfathering allocation of allowances. Auctioning would also allow for revenue recycling by governments and could therefore generate a double dividend.

The introduction of a price floor and ceiling would also substantially limit the possibilities of large variations in the carbon price and therefore increase certainty for investment in low carbon technologies (Helm 2007b, 2009). A price-floor could be introduced by an agreed carbon tax making it a hybrid scheme where a low tax would

[52] The EUA price fluctuated mostly around 12-16 Euros per tonne of carbon in 2009

prevent the price falling below a certain level. A ceiling could be imposed by establishing buy-out clauses. This could be done centrally at EU level to harmonise the tax floor across the EU.

The EU ETS is currently linked to the Kyoto flexible mechanisms through the Linking Directive[53]. This allows for lower abatement costs as well as technology transfer to developing nations. The CCC has stated that there should be absolutely no limit on the amount of EU ETS allowances purchased, as total emissions within the EU should remain the same. However they advise that credits from Kyoto flexible mechanisms, such as the CDM, should be limited in meeting the carbon budgets, even though these projects would theoretically achieve abatement at lowest cost. This advice is due to concerns that no significant reductions would be made if the use of Kyoto credits are not limited as many groups are sceptical about the true benefits of such project credits. This scepticism is due to the difficulty in proving the 'additionality' of such projects against a hypothetical baseline scenario. If these CDM projects are not credible then this undermines the whole process. Therefore domestic reductions which can be accurately measured are preferred. However, the Linking Directive already allows the use of Kyoto credits in the EU ETS although their use can be limited by governments in their National Allocation Plan. Price credibility and stability could also be enhanced in the future by linking the EU ETS with other trading schemes worldwide once those in the USA, Australia and Japan are functioning. Although it would go some way to achieving a worldwide carbon price though this would not be unproblematic as a merging of prices, assuming price differentials, would be socially but not pareto optimal, as those buying in the 'low price' scheme will now face higher prices and those selling in the 'high price' scheme will now receive a lower selling price. The success of linking will be dependent upon the characteristics of both schemes, and the more similar they are, the easier linking will be. Do they have the same emissions reduction targets? Are different GHGs covered by the schemes? How are the schemes' units of currency exchanged?

More generally, the time-inconsistency problem is caused by the fact that policy-makers change after a certain number of years, or to put it another way, time-

[53] Directive 2004/101/EC

inconsistency is a by-product of the electoral process. Ulph and Ulph (2009) acknowledge this and put forward an argument that other policies, such as R&D subsidies, must be employed in order to induce investment in clean technologies, in cases where governments cannot commit. They argue that where a future government may attach a different weight to the environment, the current government has an increased incentive to have the necessary investment take place but the private sector has less incentive to invest. Therefore additional policy instruments may be required to achieve the level of investment needed. However one issue with this model is that it ignores the requirement of substantial funding from the current government and is it fair to incur heavy costs now through subsidies. This governance issue may differ at EU level as policies tend to change a lot less quickly. The EU as an organisation is long-lived and may be better placed to deal with such time-inconsistency issues but it is more susceptible to bureaucracy in achieving its goals. Helm (2009) agrees that the EU level is more appropriate for tackling climate change than many national schemes, given the global nature of the problem, but he warns against the climate change 'pork-barrel' becoming the new Common Agricultural Policy where vested interests produce inefficient polices that exist long past their usefulness because rents are there to be captured.

Domestically in the UK there has also been use of energy and carbon markets as policy levers to achieve emissions reductions. The Climate Change Levy is fundamentally a tax on energy intensive sectors. Large discounts up to 80% are available however for sectors that can form Climate Change Agreements (CCAs). Also from 2010 the introduction of the Carbon Reduction Commitment (CRC) will provide a carbon trading scheme for large businesses who consume more than 5000KW per annum e.g. Tesco, Universities. Revenues from the CRC auctioning process will be recycled back to participants providing they meet efficiency targets.

Renewable Obligation Certificates (ROCs) were introduced as a means of financially supporting renewable electricity generation in the UK.[54] The ROC scheme in the UK has been often criticised, initially for not differentiating among renewable sources

[54] This requires electricity suppliers to provide a certain amount of renewable power, or face a penalty. This should increase low-carbon electricity production and thus displace emissions from dirtier sources, whether that is the end goal or not. For an overview see (Morthorst, 2000)

which meant a dash-for-wind, as it was the most cost-competitive renewable covered by the scheme. This has recently been reformed into a "banded" ROC scheme. Also, the slow planning process is widely regarded as having hindered renewable development. It is not clear if the purpose of the ROC scheme is to reduce emissions or promote a new growth sector. The UK government has no clear energy policy goal to use renewables as a tool for economic growth; however the Scottish government has made this priority explicit. Also the ROC support scheme applies to electricity production which is already covered by the EU ETS and therefore raises important questions of policy interaction. The EU does have a renewable energy target of 20% increase by 2020 however there is no EU-wide renewable certificate scheme and so renewable policies differ across the EU, with many other countries using feed-in tariffs, a direct subsidy rather than a trading scheme, to good effect.[55] There are plans by the new Conservative/Lib Dem coalition government to introduce a feed-in tariff in tandem with ROCs and also to possibly introduce a carbon tax.

How these policies interact is of critical importance to energy policy and the success of reducing emissions. There is a tension between the emissions trading scheme on the one hand and domestic targets or renewable goals, on the other. In theory a trading scheme should achieve abatement at lowest cost and having additional policies would add no efficiency gains (Sorrell and Sijm, 2003). There needs to be at least as many policy instruments as policy goals. However, even using a single policy instrument in order to achieve each government policy goal may prove to be problematic due to the interlinking and potentially conflicting nature of these goals. In practice it is not clear that the UK government are even using separate instruments for each goal of energy policy and clear rules regarding the interaction of these objectives have never been outlined.

The CCC believes that carbon markets cannot be relied upon completely to achieve the carbon budgets:

"The Committee recognises the benefits of carbon markets, which can help achieve emissions reductions at least cost and drive emissions reductions in developing countries. But we believe that it is essential for rich developed countries to achieve

[55] This target covers all energy sources including electricity, heat and transport

significant domestic reductions to drive the development of required low-carbon technologies and to be on the path to meeting the deep domestic emissions cuts that will be required in the longer term"[56]

This statement seems slightly odd given the clear distinction and tension between the first and second sentences. What they seem to be advising is enforced innovation in developed nations, perhaps through renewable policy targets, but goes no way towards limiting their high-energy imports. Sorrell and Sijm (2003) propose that although additional policy instruments bring no efficiency gains, they can achieve other objectives such as stimulating investment in R&D where inducing initial investment is difficult because of moral hazard and imperfect information. This is similar reasoning as Ulph and Ulph (2009) in justifying R&D in renewable technologies. There is a role for markets but in the long run developed nations will have to change infrastructure substantially to achieve necessary emissions reductions, and to do this there needs to be immediate investment in new technologies. Surely these domestic reductions would be better achieved with an appropriate domestic policy lever for the CCC, rather than purely setting an aspirational future target. Helm (2007b) hopes that delegation of powers may be possible in the future, after an energy agency has been established for a long enough time for its reputation to be sustained through the government achieving its carbon budgets. This allows for the possibility that the CCC functions may change over time and even eventually become more comparable to the MPC.

There have so far been missed opportunities in terms of transforming and simplifying UK energy policy by incorporating other institutions' functions into the CCC. The CCC provides advice to government, while the Carbon Trust provides help for companies and organisations as well as funding low carbon technologies. The Energy Saving Trust has an even wider ranging remit, giving advice and information to anyone wishing to save energy in various ways, mostly households and small businesses. Security of supply is mostly handled by Ofgem. This overcomplicated arena is a flaw of the UK government energy policy as a whole. Helm (2007a, b) called for an energy agency which would be all encompassing. Such streamlining

[56] CCC (2008b), foreword p9

would allow cost reductions through economies of scale and possibly the reduction of lobbying by different energy-related institutions. Although the CCC cannot comment directly upon how government should decide policy, it should be able to comment upon possible policy instruments as methods for reducing emissions in specific areas. It should also be able to discuss policy interaction, an area which is often neglected by analysing what the effects of employing many policy levers at the same time may actually achieve.

Energy is a reserved matter for the UK government; however this constitutional issue has not stopped Scotland pursuing its own energy policies specifically on environment, security of supply, price and growth (Allan et al, 2008). The Climate Change Act (Scotland) 2009 has created legislation guiding Scotland towards lower GHG emissions. It is completely independent from the UK act and it has many similarities but a few important differences. The Scottish government asked the CCC to advise Scotland on: the highest achievable interim target for 2020, the annual targets from 2010-2020, a cumulative emissions budget, how to include aviation and shipping within budgets; and limits of credits to meet Scottish targets. Their report was released in February 2010 and highlights the main differences between the Scottish and UK frameworks and how Scotland can attempt to meet its ambitious 42% reduction by 2020 (CCC, 2010).

The CCC advice suggests this target is possible but setting separate targets for the traded and non-traded sectors in Scotland and making the non-traded target invariant to whether a global deal is achieved. This non-traded sector reduction would have to be around 47% to meet the overall economy target of 42% reduction in GHG emissions. The main differences between Scottish and UK policies are interesting and worth discussing. A ‘no nuclear’ policy is currently held by the government in Scotland, based mostly on political reasons, and this severely limits options available for low-cost, low-carbon technologies available to meet the demanding emissions reduction targets. Scotland also has very demanding renewable electricity target of 50% by 2020. The strict planning permission system may make it difficult for this to be achieved in time without intervention from the government. The Scottish framework also explicitly includes aviation and shipping, which are not yet included at UK level. The inclusion of aviation and shipping, whose emissions growth is

outwith Scottish control, will require more stringent reductions in other sectors. Another difference is that the Scottish act provides for annual reduction targets instead of the 5 year UK carbon budgets. This reduces the flexibility of meeting targets, as does the lack of borrowing allowed between Scottish budgets. All of these differences suggest that meeting the Scottish targets is achievable but will be a substantial challenge, especially if there is no international agreement meaning the EU target remains at 20%.

6. CONCLUSION

There is no simple way to reduce worldwide GHG emissions in order to stabilise global temperatures and minimise the effects of climate change. An international climate change agreement is necessary in the long term but this has proved to be politically difficult and laborious to achieve. Therefore domestic and regional initiatives have become essential in tackling climate change. These may take the form of emissions taxes, trading schemes and government regulation. Emissions levels may also change indirectly due to the other government energy policy goals, such as security of supply or promoting a renewables industry. One interesting institutional approach to tackling climate change is the creation of an independent body which may be tasked with a combination of: validating information on climate change, giving scientific and economic advice, monitoring government emissions' reduction targets, and having the responsibility for achieving such targets (and policy instruments with which to achieve them).

The Committee on Climate Change is a unique institution that has been created to make the UK a leader on the climate change issue. Any country willing to take the initiative domestically on climate change should be commended politically for trying to show leadership. However, such a move may prove risky in terms of reduced growth and competitiveness, if it fails to induce others to follow. There are a number of possible reasons for the creation of such a body. In the UK the most compelling motivation depends on an analogy with the use of an independent central banker to solve the time inconsistency problem, which is familiar from monetary policy. However, in practice, the institutions created to tackle these time inconsistency problems in monetary policy and carbon policy, the MPC and the CCC respectively,

differ significantly. These differences are apparent in terms of the problem they are trying to solve and also how they operate.

Firstly, the time scales involved in carbon and monetary policy differ substantially. Weightings of future generations appear to be an important consideration in analysis for carbon policy and investments in renewables have a long life cycle, so that the discount rates used in each body's analysis tend to differ slightly.

Secondly, although both bodies require judgement from committee members, there are considerable differences in the technical decisions they have to make. In particular, climate change appears to be more uncertain and far more complex to comprehend, various equity considerations have to be taken into consideration (such as an appropriate UK share of global emissions reduction efforts) and there is not the same clear link between policy instrument and goal (carbon targets and temperature) as with monetary policy (interest rate and inflation).

Thirdly, there are important institutional differences between the areas of climate change and monetary policy. The MPC is the main monetary policy institution and although it must function in tandem other government economic goals, its remit is more concise than that of the CCC. The CCC has to operate with other government energy policy goals where there appears to be considerable overlap and trade-off between these goals. Therefore the CCC remit is wide-ranging as it takes extra considerations into account. It also exists within the crowded institutional landscape of energy policy alongside other environmental and energy related bodies such as the Carbon Trust and Ofgem, this substantial overlap does not occur within monetary policy.

Perhaps due to these previous differences an important fourth difference arises. Unlike the MPC, the CCC has no direct policy instrument; there is therefore a question over its likely effectiveness in solving a time inconsistency problem and creating a credible carbon policy. In practice the CCC is the 'inverse' of the MPC in the sense that it *advises on setting a target* rather than being *required to achieve a target*, whereas the MPC is charged with achieving the target set by the government through the use of the policy instrument delegated to it (the setting of interest rates).

It is clear that the CCC is emphatically not "the MPC of carbon policy". Rather it should be viewed as a "Rolling Stern plus" body that incorporates both an advisory role, similar to Stern (2006), reflected in its recommendations of 5-year carbon budgets, *plus* an additional monitoring function to detail whether targets are being, or are likely to be, met. The CCC cannot simply be viewed as just another government advisory body or NDPB; it is heavily enshrined in legislation and is a crucial part of the UK government's climate change policy framework. Instead it must be seen as a guiding body and source of advice, which also publicly monitors government progress towards emission reduction goals, and whose independence and credibility is essential to the success of the UK effort to mitigate and adapt to climate change. It is this *plus*, of an additional independent monitoring role, that makes the CCC a unique institution within any national carbon policy and its independence is fundamental to its make success by holding political decision-making to account. Hopefully the CCC can develop and sustain a reputation for impartiality, and thereby establish credibility in climate change policy, over a time frame necessary to achieve the required emission reductions and changes in our use of carbon and other GHGs.

In its current form the CCC clearly has the potential to strongly influence and shape UK carbon policy over the coming decades and to help create a low-carbon economy. However, it may be that further improvements can be made to the CCC's role and functions. Firstly, there is a role for information provision to the general public and private sector. A credible source of information is needed to minimise the probability of events, such as the "Climategate" incident, which can seriously dent confidence in the science and economics of climate change. Information disseminated in a simple and transparent manner by a trusted independent body may help ease these issues. This is a function that could be performed by the CCC or another independent energy institution. If the CCC were to undertake this task it would allow for some simplification of the complicated carbon policy institutional setup. However, this role is more appropriate for a purely monitoring body. The CCC's strong alignment to the climate change agenda and its advisory role may compromise the impartiality of information of this nature.

Secondly, the CCC could fulfil its general responsibilities more effectively if it adopts a wider approach that includes consumption-based accounting methods for emissions, in tandem with the current production approach. This which would give a broader and useful supplementary indication of what level of emissions the UK is ultimately responsible for worldwide. Many energy intensive products are imported from countries where energy costs are cheaper and production-based accounting methods do not give a full picture of the extent to which public and private consumption by UK citizens is contributing to climate change. In some instances these production sectors may have moved from the UK. Therefore the CCC should take broader methods into account when advising on targets and advise on possible policies to achieve consumption reductions. One possibility that could be considered as a possible solution if climate change is actually to be tackled at a global level is a border carbon tax, although a tax may further harm competitiveness of some industries. However, macroeconomic impacts can be broadly neutralised by imposing a balanced-budget fiscal stance.

Therefore thirdly, if the CCC were given control of an appropriate policy, such as a balanced-budget carbon tax, they may be able to achieve the budgets and establish greater credibility, independently of other government policies. A national carbon tax may be appropriate for many reasons: inducing uncovered sectors of the EU ETS to lower their carbon emissions; raising revenues which can be recycled; and also achieving carbon price stability by imposing a price floor. It is likely that such a tax will be introduced, possibly at the EU level, but more likely at national levels.

Interactions between institutions and instruments must also be considered in depth and it would seem appropriate for the government, especially at a time of making spending cuts, to simplify the energy policy landscape. Remits of energy institutions are often overlap and can sometimes appear quite vague. These should be made more obvious and the exact purpose of instruments should be made clearer, giving an unambiguous indication as to which goal(s) they pertain to.

While we are fully supportive of the adoption of emissions targets and of the need to monitor progress towards them, it is nevertheless important to keep the limitations of targets in mind. Targets are merely indicators of progress towards a particular goal,

and from a policy perspective it is rarely sufficient simply to know if targets are being met or not: rather it is important to know why emissions are changing in a particular direction and by the amount observed. It is also important to understand, for example, the nature of the trade-off between environmental and economic goals, and the extent to which the adoption of low carbon technologies, for example, can ameliorate any trade-off. In short, there is a requirement for a modelling system that captures the transmission mechanisms from policy instruments to policy goals. No doubt DECC and the CCC are already engaged in the development of such models (and, of course, there are a number of extant UK models that might be adapted for this purpose). Such an energy-economy-environment modelling framework for the UK would facilitate an exploration of hypothetical policy packages, including the likely impact of a CCC-administered, balanced-budget carbon tax on specific sectors and on the economy as a whole. Distinguishing between covered and uncovered sectors of the EU ETS would allow analysis of interaction of a carbon tax, for example applied only to uncovered sectors, and the exogenous EU ETS carbon price. Ideally future extensions of such a model would also capture interaction of other key energy policy instruments (such as ROCs). A multi-regional variant would permit exploration of the spatial dimension that may prove critical given the nature of multi-level governance in the UK, especially since Scotland has its own climate change framework and emissions reduction targets.

References

Allan, G., McDonald, J., McGregor, P. and K. Swales (2008), A distinctive energy policy for Scotland?, *Fraser of Allander Economic Commentary*, Vol. 32 (1), pp. 46-61

Awerbuch, S., (2000), Investing in photovoltaics: risk, accounting and the value of new technology. *Energy Policy*, 28 (14), 1023–1035.

Barrett, S., and R. Stavins (2003) "Increasing participation and Compliance in International Climate Agreements" *International Environmental agreements: Politics, Law, and economics*, 3 (4), pp. 349-376

Barro, R. and D. Gordon (1983), Rules, discretion and reputation in a model of monetary policy, *Journal of Monetary Economics 12*, 101-121

BBC news (2008a), Fuel strike begins to hit supply, [Online] (updated 14 June 2008) available at <http://news.bbc.co.uk/1/hi/uk/7454149.stm>, accessed 10 June 2009

BBC news (2008b), 'Selective' knife figures blasted, [Online] (updated 12 December 2008) available at <http://news.bbc.co.uk/1/hi/uk_politics/7780057.stm>, accessed 10 June 2009

BERR (2008), Renewable Energy Strategy Consulation, Department for Business, Enterprise and Regulatory reform, London

Boemare, C., Quirion, P., and S. Sorrell (2003), The evolution of emissions trading in the EU: tensions between national trading schemes and the proposed EU directive, *Climate Policy*, 3S2, pp. 105-124

Bohringer, (2003) "The Kyoto protocol: A review and perspectives" *Oxford Review of Economic Policy*, Vol. 19, No.3, pp. 451-466

Bowcott, O., (2010), Heathrow protestors win third runway court victory, Guardian [internet] 26 March 2010, <http://www.guardian.co.uk/environment/2010/mar/26/heathrow-third-runway-travel-and-transport>, accessed 14 May 2010

Cabinet Office (2008), 'Public Bodies 2008', available from <http://www.civilservice.gov.uk/Assets/Master%209%20March%20version_tcm6-6429.pdf> accessed 28/04/09

CCC (2008a), Workplan, May 2008, London, available from <http://www.defra.gov.uk/environment/climatechange/uk/legislation/pdf/ccc-workplan.pdf> accessed 15 October 2008

CCC (2008b), Building a low-carbon economy: The UK's contribution to tackling climate change. The first report of the Committee on Climate Change, December, London

CCC (2009a), Meeting Carbon Budgets – the need for a step change, Progress report to Parliament, Committee on Climate Change, London

CCC (2009b), Meeting the UK aviation target – options for reducing emissions to 2050, Committee on Climate Change, London

CCC (2010), Scotland's path to a low-carbon economy, Committee on Climate Change, London

CCC Adaptation sub-committee (2009), Preparing for climate change, Adaptation sub-committee work programme, Committee on Climate Change, London

D'Artigues, A., Percebois, J., and T. Vignolo (2007), The Time-Inconsistency of Alternative Energy Policy, European University Institute, Dept of economics Working paper, 2007/32

DECC (2010), UK Climate Change Sustainable Development Indicator: 2008 Greenhouse Gas Emissions Final Figures, Statistical release, 2nd Feb 2010

Dietz, S. (2008), A long-run target for climate policy: the Stern Review and its critics, CCC Secretariat consultancy project

Finus, M., Van Ierland, E., and R. Dellink (2006), Stability of climate coalitions in a Cartel Formation Game, *Economics of Governance*, 7 (3), pp. 271-291

Grubb, M., and K. Neuhoff (2006), Allocation and competitiveness in the EU emissions trading scheme: policy overview, *Climate Policy (6)*, pp. 7-30

Helm, D., Hepburn, C. and R. Mash (2003), Credible Carbon Policy, *Oxford Review of Economic Policy*, Vol. 19, No.3, pp. 438-450

Helm, D., Hepburn, C. and R. Mash (2004), Time-Inconsistent Environmental Policy and Optimal Delegation, Discussion Paper 175, Oxford University Department of Economics

Helm, D., (2007a), The New Energy Paradigm, in Helm, D., (Ed), The New Energy Paradigm, Oxford, Oxford University Press

Helm, D. (2007b), Energy policy and climate change: choosing targets and delivery mechanisms, Beesley lecture [Speech], New College Oxford, Oxford, available at www.dieterhelm.co.uk

Helm, D. (2007c), Climate Change policy: lessons from the UK, Economists' Voice, New College Oxford, Oxford, 10th Jan 2007, available at www.dieterhelm.co.uk

Helm, D. and C. Hepburn (2007), Carbon contracts and energy policy, in Helm, D., (Ed), The New Energy Paradigm, Oxford, Oxford University Press, ch. 3.

Helm, D., Smale, R. and J. Phillips (2007), Too Good to be True? The UK's Climate change record, 10th Dec 2007, available at www.dieterhelm.co.uk

Helm, D., (2009), EU Climate Change policy – A critique, in Helm, D., and C. Hepburn, (Eds), The Economics and Politics of Climate Change, New York, Oxford University Press

Ingham, A., and A. Ulph (2005) "Uncertainty and Climate Change Policy" in Climate-Change Policy by Helm, D. (2005) pp. 43-76

Institute for Government (2010), Read before Burning: Arm's length government for a new administration, Institute for Government, London

Kydland, F. S., and E. C. Prescott (1977), Rules rather than discretion: The inconsistency of optimal plans, *Journal of Political Economy* 85, pp.473-490

MacKay, D.J.C., (2009), Sustainable Energy - without the hot air, Cambridge, UIT Cambridge

Maskin, E., and J. Tirole (2004), The Politician and the Judge: Accountability in Government, *American Economic Review*, Vol.94, No.4, pp. 1034-1054

McGregor, P., Swales, J.K., and K. Turner (2008), The CO2 'trade balance' between Scotland and the rest of the UK: Performing a multi-region environmental input-output analysis with limited data, *Ecological Economics*, 66, pp.662-673

McKibbin, W.J., and P.J. Wilcoxen (2002), The Role of Economics in Climate Change Policy, *Journal of Economic Perspectives*, Vol. 16, No. 2, pp.107-129

Morthorst, P.E., (2000), The development of a green certificate market, *Energy Policy*, 28, pp. 1085-1094

Newell, R.G., and W.A.Pizer (2003), Regulating stock externalities under uncertainty, *Journal of Environmental Economics and Management*, 45, pp.416–432

Nordhaus, W.D., (2007), A Review of The Stern Review on the Economics of Climate Change, *Journal of Economic Literature*, Vol. 45, pp. 686-702

Ofgem (2010), Project Discovery: Options for delivering secure and sustainable energy supplies, Office of Gas and Electricity Markets, London

Pearce, D., (1991), The Role of Carbon Taxes in adjusting to Global Warming, *The Economic Journal*, Vol. 101, pp. 938-948

Rogoff, K., (1985), The Optimal Degree of Commitment to an Intermediate Monetary Target, *Quarterly Journal of Economics*, 100, pp. 1169–1189

Russell, M., (2010), Independent Climate Change e-mails Review, available from <www.cce-review.org/pdf/FINAL%20REPORT.pdf>, accessed 15 July 2010

Sorrell, S., and J. Sijm (2003), Carbon trading in the policy mix, *Oxford review of economic policy,* Vol. 19, No.3, pp. 420-437

Stern, N. (2006), The Economics of Climate Change: The Stern review, Cambridge, Cambridge University Press, pp.

Stern, N., (2009), The Global Deal: Climate Change and the creation of a new era of progress and prosperity, New York (NY), Public Affairs

Stigler (1971), The Theory of Economic Regulation, Bell *Journal of Economics and Management Science*, 2 (spring), pp. 3-21

Turner, K., Lenzen, M., Wiedmann, T., and J. Barrett (2007a), Examining the global environmental impact of regional consumption activities – Part 1: A Technical Note on Combining Input-Output and Ecological Footprint Analysis, *Ecological Economics*, 62, pp.37-44

Turner, K., Lenzen, M., Wiedmann, T., and J. Barrett (2007b), Examining the global environmental impact of regional consumption activities – Part 2: Review of input-output models for the assessment of environmental impacts embodied in trade, *Ecological Economics*, 61, pp.15-26

Ulph, A., and D. Ulph (2009), Optimal climate change policies when governments cannot commit, *University of St.Andrews Discussion paper*, No. 0909

Walsh, C.E., (1995), Optimal Contracts for Central Bankers, *The American Economic Review*, Vol. 85, pp. 150-167

Walsh, C.E. (2003), Monetary Theory and Policy, 2nd edn, Cambridge, MIT Press

Weitzman, M.L., (1974), Prices vs. Quantities, *Review of Economic Studies*, 41, pp. 477-91

Weitzman, M.L., (2007), A Review of The Stern Review on the Economics of Climate Change, *Journal of Economic Literature*, Vol. 45, pp. 703-724